THE PREPARATION AND USES

OF

WHITE ZINC PAINTS

BY

PAUL FLEURY

TRANSLATED FROM THE FRENCH

BY DONALD GRANT

WITH THIRTY-TWO TABLES

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AUTHOR'S PREFACE

THE object of this examination of white zinc is not to revive polemical discussions now extinct in France owing to the passing of the Act interdicting, in France, the use of white lead in all paintwork in buildings.

This treatise must not be taken for anything but what it really is, namely (1) a practical and scientific guide to the judicious use of white zinc; (2) a sketch of its fluctuating history; and more especially (3) as complete an exposition as possible of the indispensable technical knowledge required by practical men to understand this white pigment well, so as to be able to demand of it all it is capable of doing, and not to require of it what it cannot do.

There is no need to fear double dealing in the Author's developments; his explanations are always sincere and clearly expressed. Likewise, no one will find under his pen any form of advertisement, for it is as a practical and not as a commercial man that he writes.

On the other hand, if some of his colleagues who have read his other books on paint think they ought to be astonished, and to ask why he now poses as the diffuser of scientific knowledge on the use of white zinc, he replies that therein lies a legal necessity; and whatever may

be the opinion of trade experts on the respective merits of zinc oxide and white lead, it would be puerile to make of it a condition of the hereafter, since it is the law itself which places us under the obligation of abandoning the latter and using the former. What is the good, therefore, of recriminating? Is it not preferable to bow before this law, if not with good grace, at least in a dignified and intelligent manner, whilst searching for the best of which its application is capable?

By following this advice, the painters of France will reply in the wisest possible way to the accusation of routine, which people are always so ready to hurl at them; and they owe it to themselves to show that they are as capable of discussing white zinc as they are of discussing white lead. It is an affair of goodwill and common sense. Such is the thought that has guided the Author in this small treatise, which he has just written with the most complete good faith after five years of repeated observations and patient researches, renewed and controlled experiments. He dedicates them to his colleagues without distinction of school, category, or nationality, with the desire of being useful to the generality amongst them, and in any case to interest them.

The Author's work is free from all idea of lucre or mercantile profit; there will not be met with, as already said, any form of advertisement, and still less particular or special recommendations of any brands of white zinc. The Author, moreover, considers that every brand has its respective value, but that none of them can, as yet, so excel as to be the ideal white zinc having all the collective properties reunited in one.

There will be found in this small volume the description of the qualities and properties of commercial white zincs according to the nature of their composition and their method of manufacture, as well as the indication of their particular suitability or their most favourable use, taking into account the different kinds of painting in buildings. There the Author's instructions stop, so as to designate the products sold in the colour trade; but these indications suffice for the painter who will be amply instructed so as to be able to fix his choice wisely, and to take the brand of white zinc which responds best to his needs as well as to the nature of his work; or again, by taking white zinc of different brands or from different firms, according to the properties and the peculiar advantages of each of them.

In concluding this preface the Author must assure those of his colleagues who have had no wish to examine the question, or who are not interested in it and who are still sceptics in regard to white zinc, by telling them that to-day we possess more unctuous oxides, with greater covering, drying, and resistant properties, than the oxides of former days. Then there was no opposition. The last few years opposition has come; it has created emulation amongst the different manufacturers of this product, which has stimulated their efforts, induced researches towards possible improvements, some of which have already been brought out. Further progress will certainly be realised, for it is always necessary to count on scientific discoveries. Everything is not yet said, as regards the manufacture of white zinc. As regards the manufacture of a colour base for painting, it will be seen further on what the Author

thinks upon this point ; and one need not be astonished if, in the near future, we see appear *the* substitute for white lead, that is to say, an economical product, stable, very tractable, harmless, with a fine appearance. Science, as M. Brunetières has said, has never failed, and always reserves for us genial surprises.

P. F.

PARIS, 1911.

THE PREPARATION AND USES OF WHITE ZINC PAINTS

FIRST PART

CHAPTER I

GENERAL REMARKS

IF, to form an opinion, there were only the analyses of long documents to bring to bear thereon, if there were only the allegations, objections, and assertions which have been made in regard to the use of white zinc in the painting of buildings to consider, there would be great difficulty in coming to a conclusion as to its actual value and its real properties. After more than a century of controversy and hotly contested campaigns, the question of its integral and exclusive use is not, even now, definitely settled, and yet there has been no scarcity of more or less scientific discussions, nor of more or less technical demonstrations.

But by placing oneself, as should be done, that is to say, outside the pale of all exaggeration, whether committed on the one side or on the other, a very striking

and very precise fact, nevertheless, stands out in bold relief, and that is, that practical men and theoretical men have never agreed, at least the greater number of them, and that they have always expressed a different, if not quite a contrary, opinion. The former, relying on practical experience and their daily observation, denied the greater number of the good qualities which the latter, scientifically or theoretically, attributed to white zinc; then, the latter accused the former of ignorance, ill-will, and of conservative routine, being themselves in their turn declared absolutely incompetent to touch a question so essentially professional and technical. This disagreement between practical and theoretical men seems now to be slightly moderated, but it exists still and continually survives. It may be said that it will continue to exist until science or human genius shall discover the ideal, integral, and perfect substitute for white lead, either by improving the processes of manufacture and grinding of white zinc, or by treating, in a peculiar and new fashion, the oils which serve it as binder; or, better still, by replacing it, itself, by another metallic base, responding better to the economical and practical requirements of the painter! The author has more hopes, in the second part, of the first method, special treatment of the oils, than in the second. Whilst waiting until this eventuality occurs, the author has tried to find the true causes of this secular disagreement between the recognised authorities, on both sides, between theoretical science and practical science. He has tried to determine exactly on which side the greatest amount of truth, the most exact appreciation of the facts,

lay, and, as the scrupulous examination of the reciprocal objections showed that a large number of them were well founded, he tried to find, if it were possible, to make these different assertions agree, by seizing from amongst them everything that was practically realisable in regard to the good execution of painting. To be impartial in his researches it was necessary to silence, in himself, every previous professional opinion, and to stifle his personal convictions, as a practical man, of the superiority of white lead. That was absolutely necessary, so as to take in hand and follow up, for several years, the examination of so complex a question, and, above all, to terminate it by the sole method of control of any value in this connection—that of comparative experiment. This was done with the greatest conscientiousness, taking into account very greatly the theoretical assertions, too much mistrusted in a general way by practical experimenters of the preceding or the present generation, but always making a point of the practical experience acquired by our former and our contemporary colleagues—an experience too much mistrusted by all theoretical men, including those of the present time. The essential elements of his examination are not given here. It might be objected that the author's way, the author's method, is not the right way nor the true method. What is given here are the concordant results of scientific technique and trade technique which these elements have supplied, his observation as a craftsman, explanations and reports of the experiments which have been made in France and in other countries, the essential points of which have been given in preference to his own

opinions, firstly through a spirit of impartiality, and the more so as all these experiments and these explanations fully justify his opinions and confirm in all points the theories now to be enunciated and developed.

Technical Principles

From the author's long examination, taken as a whole, and from the comparative experiments undertaken by him, personally, on all the white zincs at present on the market, without taking any side and without the slightest bias of any sort—in spite of the author's profound conviction of their comparative inferiority against white lead—and from the careful examination of the observations and serious objections which have been raised prior or subsequent to *the last campaign directed against white lead*, as well as from the practical and secular experience of painters, the author concludes therefrom and from all the evidence that the use of white zinc requires a particular technique and knowledge of certain special principles or precepts concerning its rational use, *principles the observation of which is required to insure the execution of good painting*, from every point of view, from paint which has this product as its exclusive basis. It will therefore be necessary to commence, first of all, by the enumeration of these precepts or principles, before entering into the details of pure practice, for they form, in a way, the theory of painting with white zinc which has been so much contested already without being sure that we shall not have to do battle again, should a propitious moment come unexpectedly. The enuncia-

tion of these principles follows, accompanied, as occasion requires, by a few explanations or certain developments.

I. White zinc, owing to its nature and its low density, *absorbs much more oil than white lead. It takes at least double* to be brought to a state of fluidity, equal to the fluidity of white lead paint.

II. Like the majority of other pigments, with the exception of white lead, zinc oxide owes its comparative durability to the vehicle with which it is in conjunction, to the *binder* with which it is mixed—and every one knows that *linseed oil is the best of paint binders*, naturally of an oily, fixed, and drying nature, a property which allows it to assimilate pigments, and by itself alone to resist the weather for a considerable time. Therefore, the more oil present in white zinc the greater its durability.

III. Owing to the above two reasons, white zinc, to be used judiciously in painting, requires *different* preparation from that in common use, the difference of its density and the anxiety for its durability so require it.

IV. If the zinc white propagandists (theorists), in their writings and in their discourses, have continually advocated the application of thicker coats than those with a white lead basis, it is owing to neglect or default of technical knowledge, and solely with the object of obtaining, with white zinc, identical workmanship with that got from white lead, as regards covering power and number of coats. This advice is, virtually, a professional heresy, which the author cannot advocate, and which he must oppose, at least morally, for this way of looking at the matter and acting is far too contrary to

the theory and constant practice of painting, in which it has always been recognised and taught, that *two thin coats are worth far more than one thick coat.* In fact, a coat of paint applied thin (without going to extremes) has the advantage of being more easily spread, of penetrating better, and especially of hardening more quickly and more completely, than paint applied thickly.

V. In good technique, the coats of oil paint, whatever may be the pigment used as base, should be thinned to the same normal and uniform fluidity, but fixed by the number of coats recognised as necessary, having regard to the covering power of the pigment used as a base; the fluidity should only vary with the order of succession of the coats, or the degree of absorption of the object, and not according to the nature of the pigments. Unfortunately, the blind practice, consecrated by use and wont, of three regulation coats only, specified by French architects, is found [in France] to be a very serious obstacle to the application of this principle in rational technique, and becomes in itself the great cause of the use of thick coats, in painting with paints with a white zinc basis. However, the author does not mean to say that it is quite impossible to make a good job with only three coats of white zinc; that is easily done on common work. It is, however, necessary to know how to distinguish what sort and what quality of white zinc should be used for such and such a given work, for white zinc is subdivided into several varieties, owing to the diversity of its sources as well as to the differences in its methods of manufacture. Now, the sources and the

manufacture of zinc oxide, together with the method of grinding, are respectively the determining points of its qualities and its properties.

VI. It is important to know that, in painting with white zinc, it is necessary to alter the turn of the wrist, just as it is necessary to alter the preparation of the coats. Two excellent reasons may be quoted in support of this statement, first *the greater thickness of the layer to apply*, *then the natural rigidity or want of suppleness of white zinc which renders the coats less flowing*, *less unctuous*, *than white lead*. This well proves that painting with white zinc is a change for every practical painter accustomed, exclusively, to the *mellowness* of white lead; and that this practical man, in order to paint with white zinc, *must give greater attention and more time than he usually spends*, *on the same job*, *when working with white lead*. But, from a strictly practical point of view, the change in the turn of the wrist is readily acquired, a little observation and goodwill suffice to seize the stroke. One can, therefore, without any great effort of intelligence and attention, obtain, with three coats, on *common work* executed with white zinc, amply covered paintwork, able to bear comparison, for a somewhat long time, with painting done with white lead, as the author has himself proved in many experiments, by placing, alongside each other, on the same surface, coats of paint with a zincic basis and others with a lead basis. However, to get a good job with three coats, good white zinc must be used, and not low-priced *sorts*, or *numbers*, ground and mixed in the factory, for the use of cheap contractors. In spite of this eventual possibility of doing passable painting with three

coats of good white zinc, the principle enunciated in paragraph V must always be borne in mind; and it is well to say that, in somewhat careful working, there is a great, a very great, practical advantage in applying coats of less thickness and in giving *at least one additional coat*; the time which it takes is largely compensated by the greater ease in applying the preceding coats, besides, they dry quicker and harden more rapidly and more perfectly. The appearance of paint so executed cannot fail to gain much, at a glance from the eye, for with thin layers of the necessary number hair-strokes are avoided on the flat parts, and choking up in the hollow parts, unavoidable drawbacks of thick layers. As to the durability of painting executed in this normal and rational manner, it is unquestionable that it will be much greater than that of thick coats. This principle is, in itself, too rational to be disputed.

VII. It is none the less important for the painter to know how to choose his white zinc for the work he has to do; reference has already been made to this axiom, which the author regards as a trade necessity, which he is now going to develop at somewhat greater length than the other points to be considered, taking its importance into account, and because it is a technical novelty for many painters. It is generally believed that oxides of zinc, declared to be absolutely pure and perfectly white, are the best, and that they should be regarded as superior in every way. It is a mistake which interested parties entertain purposely; for it is an advantage to certain merchants or manufacturers who fear the competition of similar products of other origin or other manufacture

than theirs, and to which a slightly different chemical composition sometimes gives less lustre, and not so good an exterior appearance. It should be known, that every white zinc declared genuine, and guaranteed without mixture, may be regarded as a pure oxide,[1] even when analysis discovers in its composition the presence of certain foreign bodies, for no ore, no mineral, furnishes absolutely pure zinc; this metal always contains foreign bodies, the greater part of which are eliminated in the course of the operations which convert it into white zinc, either by direct oxidation or by burning its vapours. But this elimination is never complete, in the case of the whole mass of oxide obtained, a good part of which still contains large traces of these foreign bodies such as cadmium, arsenic, but *chiefly lead, which is found in all European white zincs* in variable quantities, infinitesimal in some, a little greater in others, reaching from 1 to 4, to 5, and up even to 7 per cent. The lead content of a white zinc is not always the cause of its inferiority, especially from the point of view of the durability of paints. This proportion of lead, even up to 7 per cent. in a white zinc, is precisely a cause of improvement in its properties, because on the one hand it is too small to seriously injure them; on the other hand, it however is strong enough to modify them by communicating to the oxide of zinc suppleness, opacity, and, above all, a greater affinity for oils. Whence therefore comes the fear of certain manufacturers of declaring the percentage of lead in their white zinc?

[1] TRANSLATOR'S NOTE.—This reasoning and that immediately following is in my opinion unsound. No argument can render an impure substance pure.—TR.

Simply not to wound the prejudices of painters to whom the absolute purity and immaculate whiteness of the white zincs of such and such a brand of repute has always been boasted and recommended.

Far be it from the author, the thought of trying to discredit completely purified white zincs, *i.e.* the lighter oxides, more flocculent, more fine. What he desires to say is, that they should not be the only ones to merit the esteem of painters, and if, in actual practice, they play an important rôle, the less completely purified oxides, or the less white, have a still greater rôle to play, which will be forthwith explained.

What has been said as regards the composition of white zinc applies quite as much to its exterior appearance, to its colour, in which it is not always necessary to seek for absolute whiteness, since the greater part of the painting done on buildings is executed in coloured tints, to which the white serves as a basis. Are the whitest white leads indisputably the best in all points? No. Absolute whiteness is only a secondary quality, whilst the covering power, the resistance, and durability form the essential primary property, and that more so in the case of white zinc than in the case of white lead, for the extreme whiteness of both does not assume any real importance, except in the execution of perfectly white paintwork, *which is rare enough*; the palest paintwork is generally tinted, and though in a light tint, that suffices amply to mask the difference in whiteness which exists between the different whites. In fact, there is never any great difference in shade between them, and this difference in tone has never been regarded as being an

obstacle to the colouring of paints, even in the case of delicate tints.

In this respect only the whites used in good paintwork must be taken into consideration, and not coarse whites for coarse paintwork. Let it be well understood there is no necessity to exaggerate anything. The following affords a very striking proof of what has been advanced concerning the respective value of the property of durability, of the property of fineness or of whiteness of a zinc oxide. All the factories only make a single oxide, that which they obtain by treating the metal which belongs to them, whether it comes from their own ores (which is not often the case), or whether they buy this metal; and yet although only producing, and being unable to produce more than a single oxide, the whole of them sell several sorts or numbers of white zinc of their sole manufacture, which may be reduced to two chief types—an ordinary white, or a snow or superfine white. These two typical products are from the same source, of the same nature, and are generated by the same process. Only the first is heavier, not so white nor so fine as the second, which is purified, very white, very fine, flocculent and light. What say the circulars and other prospectuses of these different manufacturers?—"We recommend our *ordinary* white, not so white nor so fine, to be preferably employed in priming and for outside work because it has greater durability." What, then, did an important white zinc house supply for certain comparative official trials? No. 2 oxide, not so white nor so fine as No. 1, but more durable! Now, as the whiteness and the fineness are only the result of more complete purification, it follows that the less purified

zinc oxides are the best from the point of view of durability. And when it is said that the permanency and durability of a white zinc paint does not depend on the real and absolute purity of the zinc oxide, such statement is the exact truth. Therefore in actual practice it would be more rational to search for very pure and superfine zinc oxides, where whiteness or fineness is required above everything else. In all other cases where durability is the first consideration they should be put to one side and the so-called inferior oxides preferred, less perfectly pure from a chemical point of view, but of greater durability and covering much better than the completely purified oxides. As a second practical conclusion, working conformably with the logic of these facts, in applying the first coats of fine work, less pure zinc oxides will be used, finishing with coats of more virgin white and superfine oxides. Such are the principles of rational technique concerning painting with white zinc, which the author's researches and experiments have induced him to collect, to control, and to publish, so as to assist by judicious counsels such of his colleagues who do not find themselves in the necessary circumstances to conduct such researches, nor to give themselves up to such experiments. After these sketches of elementary technique, which it is advisable to read twice, rather than once, we now enter into the details of exact practice, and conformable with the theory just developed.

CHAPTER II

PAINTING ON WOODWORK

Ordinary Outside Work

It has already been said, that it was important for the painter to know how to discern the nature and the property of the products which he uses. It may be added, that he should also know the why and the wherefore of the operations which he performs. Preaching from precedent, the author's explanations will always be accompanied by the theoretical reasoning which inspires them. Thus, to paint on wood, if we have to deal with white zinc and if we recall that *white zinc absorbs far more oil than white lead*, it will be seen that the preparation of the coats ought to be made in a different manner, that is, *with more oil* than in the case of white lead. The use of white zinc, therefore, *forces the painter to push the oil* to a far greater extent, at first owing to the nature of the product itself, which *devours* a great quantity of it; afterwards, because the white zinc paint cannot have any adequate durability, unless it be used, in an oily condition. But oily coats on wood are injurious to a good condition of the paintwork, especially in the beginning of the work, for they may afterwards beget

spots, cracks, or wrinkles. However, white zinc being *more brittle*, *more dry*, than white lead, is owing to these facts, and to its *inertness* in oil, less liable to spot by excess of oil, and the oil can thus be pushed [into it] with much less danger. Accordingly, the painter ought to keep his priming (first) coat comparatively oily, compared with the preparation of a similar coat made with white lead. Say, for example, the following proportions:

FIRST COAT

TABLE I.—*Showing the Composition of the First or Priming Coat of White Zinc Paint on Woodwork.*

	Lbs.	Gallons.
Ground white zinc paste in oil	100·0	...
Oil	30·6 – 31	$3\frac{1}{3}$
Turps	21·0	$2\frac{1}{2}$
Drier	2·5 – 3	...

If these figures do not give great scope, in the proportion of oil and turps, and if the amount of drier seems large, it is because of the rubbing down with glass paper, which is always done very carefully, on the priming coat before filling up; rubbing down cannot be done efficiently on actually greasy or undried paintwork. Moreover, too lean a coat will produce a crumbly foundation, very easily rubbed off. Besides, the wood not being fed enough, the priming would have almost no effect, so that the succeeding layer, normally thicker, would penetrate less and in a very unequal manner, thus forming dull patches

of considerable size, which it would almost be impossible to hide with the third and last coat; that is why a preparatory coat is required in which oil must predominate, but not in excess.

SECOND COAT

This coat should necessarily be kept thicker; for this purpose all that has to be done is to diminish the oil, say:

TABLE II.—*Showing the Composition of the Second Coat of White Zinc Paint on Woodwork.*

	Lbs.
Ground white zinc paste in oil .	100
Oil	20
Turps	10
Drier	3 - 3½

THIRD COAT

In finishing ordinary work, the vehicle of the coat consists of oil alone, without turps.

TABLE III.—*Showing the Composition of the Third Coat of White Zinc Paint on Woodwork.*

	Lbs.
Ground white zinc paste in oil .	100
Oil	23
Drier	3½ - 4

INSIDE WORK

For the ordinary painting of inside woodwork the method described does not need to be altered; it is, however, necessary to guard against painting with really lean coats, which would lead to somewhat rapid crumbling when there is no absolute necessity to work badly. The painter can, without fear of yellowing, make tints of equal quantities of turps and oil, without ever making them thinner. This proportion must be regarded as a limit for the amount of turps on work of this category. In more careful working in uniform tints, flat or lustrous, it is necessary to work on a specially prepared foundation, the *enduisage* of which about to be described is the essential operation.

Formulæ (Recipes) and Remarks on "l'Enduisage au maigre."—The *enduisage* of indoor woodwork is necessary in the case of all work which is out of the ordinary common-place work of three simple coats, such as the painting of saloons, dining-rooms, principal bedrooms, woodwork of vestibules, and staircases, especially when the latter are to be decorated; *enduisage* is again necessary in all painting on woodwork which is to be varnished, such as the painting of shop-fronts and the large doors of fixtures, carriage gates, or street door (portes de rue) signboards, pictures, etc. The "enduit" to apply in these two circumstances is of the same composition, that is to say, that both indoor and outdoor woodwork is coated by the same process *au maigre*, *i.e.* lean or with little oil, contrary to what is always done on plaster, which is always *enduit au gras* (fatty, or with abundance of oil).

In the *enduit maigre* with a white lead basis, it is always turps which predominates, by far, in the mixture; it often enters therein almost alone, with only the proportion of oil contained in the stiff white lead paint. But owing to the nature of white zinc, and in accordance with the principle laid down from the beginning of this examination, it is absolutely necessary to modify preceptibly the composition of this *enduit*; *in one word, it is necessary to push in far more oil*, so as to get both durability and suppleness. However, the oil must not run to excess, for fear of blisters and cracks afterwards. The following are the proportions which the author found to answer the requirements of this class of work:

TABLE IV.—*Showing the Composition of a White Zinc "Enduit" on Wood.*

	Lbs.
Ground white zinc stiff paste in oil	100
Oil	10
Turps	12
Drier	3 - 3½

Mix sufficiently, then harden with about 90 lbs. Paris white. It will be seen that in these proportions the turps only dominates by one-fifth of the weight of the oil, whilst in a white lead *enduit* the turps always predominates by three-quarters at least. The recipe given above yields an *enduit* very fit for both use and durability. The author has executed large surfaces on wood with it. A second application ironed (ferré) (that is to say, smoothed

with a dry knife), very nicely without there being any upliftment nor any tearing, which would not have been the case with less oil; it dries in two days. It may be repainted on the top in eight days with the assurance that the paint applied will not sink into it.

It must, in all truth, be stated that *a white zinc enduit is not by any manner of means as easily used as a white lead enduit.* The less unctuous white zinc yields an *enduit stubborn enough to spread, which frequently rolls under the knife.* It is here very necessary to change the turn of the wrist, or it is then the quality of the white zinc, which it is necessary to know how to choose.

It is in no way indispensable, or even preferable, to make *enduits* with superfine or chemically pure zinc oxide to obtain good results, for a white zinc of less absolute comparative purity and fineness is to be recommended in preference, in virtue of the famous precept enunciated in the preliminary part of these instructions:—*The excessive purity of a white zinc is not an essential condition of its property of durability*, and in the present case, provided that a genuine oxide be used and not an admixture, there would always be an advantage in using a second quality rather than a superior quality, a heavy oxide rather than a light oxide. The same remark has been made in regard to painting, and the author maintains it more strongly than ever, whatever pain it may cause certain personalities to feel, whose conviction is not sufficiently impartial, or good friends and comrades whose good faith is not to be doubted, but who are benevolent believers rather than hardened logicians. It will be seen, moreover, that this assertion of the author

is not an act of irrational trickery, and the explanations which follow will sufficiently prove that it is solely the difference in the class of work which leads the author to advise the judicious use of different qualities of zinc oxide, according to whether it is desired preferably to obtain durability or appearance in the paintwork, or if it be desired to combine both advantages!

CHAPTER III

BETTER-CLASS PAINTING ON WOODWORK

INDOORS

Flat Painting — Ordinary Lustrous Painting — Extra Brilliant Paintwork—Enamel Painting—Painting of Indoor Walls and Ceilings—Varnished Paintwork—Waxed Paintwork or Encaustic

ON the *enduisage*, when dry, the painter then proceeds to the usual operations, in the customary technique, to finish the work: slight pumicing, reinspection of the filling up, under coats, and finishing coats. But great care should be taken not to begin this finishing work, whatever it may be, before the *enduit* is perfectly dry and hard. This hardening takes, on an average, four to eight days according to the season and the exposure, but above all, according to the nature of the white zinc used, and the care taken in its manufacture, for it must be observed that white zinc of the same origin and the same manufacture may behave very differently in paintwork, according to the treatment to which it has been subjected in grinding, and the care taken in the operation.

Rubbing down, or pumicing, should be done with care and lightness. The refilling up should, naturally, be done with a zinc mastic, hardened with sifted chalk (Paris

white). This mastic should not be tinted, except when working on an *enduit* which has been tinted for the requirements of the job, especially, in the case of woodwork: (1) in imitation of other woods, or (2) in uniform dark tints, more often met with in outdoor work than in indoor work, at least of the kind being dealt with in this chapter. The mastic used in refilling up is given three days in which to dry, and it can then be painted upon without fear of dark spots.

Painting with a "Flat" Surface.—To paint, so that it will dry, with a flat surface, the first coat is applied to the *enduit*, somewhat oily, compared with the formula of the second coat, applied in ordinary working, already given (Table II. p. 15), $\frac{2}{3}$ of stiff paint and $\frac{1}{3}$ of total fluids, the oil being double the turps and even more, with three per cent. of drier. A flat surface will be obtained more readily on this rather oily preparatory foundation. The last coat can then be applied. This is prepared, not with turps alone, as in the case of white lead, but by simply using turps *in excess*, the coat being mixed in the proportion of $\frac{2}{3}$ stiff paint and $\frac{1}{3}$ liquid, turps predominating this time by $\frac{3}{4}$ on the oil, with 1 or 2 per cent. of driers at the most,—for the drier is, especially in painting with white zinc, detrimental to the success of the flat surface, and it is better to let the drying hang on a little longer than to push it, as has to be done in other styles of painting with zinc oxide.

As to the actual execution of the work, properly so-called, it goes without saying that the coats should be applied with all necessary care. The coat is well spread out, and crossed more lightly, but more often, than with

white lead, watching the smoothing down under the flat brush or *badger* very particularly, which must be done lightly and repeatedly, by successive and alternate crossings, in both directions, so as to flatten out the edges as much as possible, for white zinc has always a tendency to show hair-strokes: to obtain it uniform, it must be *worked*, and it is precisely that which constitutes the chief turn of the wrist in its special use.

Ordinary Lustrous Painting.—It is very rare, in fine indoor work, that the glossy appearance which the oil imparts to the coat is left on the surface of the paint. It is all done flat, as just explained, or all lustrous, by means of the varnish paints, enamel paints, japan paints, porcelaine paints, etc., now the height of fashion.

But if it be desired to produce paintwork which will shine of itself, the composition of the formula of the second coat, on wood previously indicated to serve as the first coat on the *enduit*, is modified slightly, and instead of a large excess of oil, oil and turps are used in equal proportions, say about 15 per cent. of each liquid, calculated on the stiff paint, so as to have a hard foundation on which the final coat can rest better, which is then rendered lustrous by an excess of oil, or even of oil to extent of $\frac{3}{4}$ of the liquid, which enters into the coat, but increasing the drier slightly, so as not to have to wait too long for it to set and dry. The paintwork can also be rendered glossy by addition of a special oil, called *Dutch Oil* (stand oil), which is incorporated in the liquid paint, after it is mixed, in the proportion of 3 to 4 per cent.; but in spite of the intrinsic properties of this varnish oil, which

in fact greatly increases the brilliancy, it must be borne in mind that its viscous consistency causes the liquid paint to string, and that the paint tends to run after it is applied, and that moreover it retards drying and more especially hardening. Now these are two defects which are intensified to the full with the use of white zinc, the drying and hardening of which are already far too slow. Besides Dutch oil (stand oil) produces a lustre, the duration of which is very short, and in many cases is very ephemeral.

Extra Brilliant Paintwork.—A more beautiful lustre cannot be given to paintwork than by means of enamel paints, after the Ripolin style, and of which the designations vary, as much as the manufacturers are numerous—enamel paint, crystal, lacs, japan, etc. etc. There are many on the colour market, at the present day, where no manufacturer fails to have one of his own. The greater number of these enamel paints are very pretty, very good, supple, and durable. Considerable quantities are used, owing to the prevailing fashion of all uniform paintwork, and alas all of a uniform tone, which is far from bringing business to painters, the more so as the use of this style of article has now become habitual to us and forms part of our home-life. The householder himself paints [every man his own painter]. It is so funny. He also makes his *valet de chambre* paint, the coachman and even the lady's maid. Just think of it, you have only to buy a little pot, and a brush, and go at it. "Thomas, paint this window, and then the front door. Here's the paint and brush." "Jane, give a coat of paint to this seat, and the table tops. Ask Thomas for the paint pot and

brush after he is finished." And there are our ready-made painters, who daub away with sheer joy if not conscientiously; they even venture to paint the walls, only that is warm work; they finish the job, however, through sheer vainglory. But they do not start again. Painters are accustomed to that sort of thing (it is very fortunate, madame), and we will only do little things in the future (still more fortunate); such is the new fashion! Such is progress!

But, in fact, enamel paints are specially intended for the use of painters, and it is from this point of view that it is desirable to speak of them here. In applying enamel paints, the most important point is not in spreading them, but in preparing the foundation (undercoat); or to speak more exactly, it is as essential to lay a good foundation (undercoat) as to know how to apply them, as they have only one real function—to finish off the work, in the form of an enamel, in the same way as varnish-resins and oil do when applied in the form of a varnish. The undercoats ought, therefore, to be prepared with as much care as when they are to be varnished. It is necessary, therefore, first to form an *enduit*, then to pumice (rub down). On well-made *enduits* a slight rubbing down with glass paper amply suffices; then fill up once more, allow the mastic to harden, give an undercoat, and sometimes two undercoats. Only fine work, let it be well understood, is being described. The undercoats need not be oily: on the contrary, they must be kept lean (poor-bodied) to avoid tackiness and the glaze which all oily undercoats produce. The undercoat or coats on which any enamel is to be applied are made thus:

TABLE V.—*Showing the Composition of the White Zinc Undercoats for Enamel Paints.*

	Lbs.
Ground white zinc stiff paste in oil . .	100
Oil	8
Turps	22

N.B.—It must be borne in mind in mixing white zinc liquid paints, always to begin by adding the oil to the stiff paint, then mix the two together, and add the turps last. This point is of greater importance, the greater the amount of turps. Enamel is, therefore, applied on a poor-bodied undercoat after drying and hardening. In this kind of varnishing or japanning it requires a good hand and a good brush. The work should be done with sufficient alertness, but without hurry, working with method, attacking the work panel by panel, spreading, crossing, letting stretch a short moment, and bringing the coat up again by an upstroke with a dry brush, avoiding choking up of the hollows in the moulds, and taking particular care of the angles, in the corners, watching them after the stroke of the brush, to avoid running, the flow of which is brought back again (if it occurs) by an upstroke with a dry brush.

Painting of Indoor Walls and Ceilings.—Although all the previous descriptions have been given, as applying to indoor painting and woodwork, they are none the less applicable to paintwork of the same style on walls and ceilings, the sole difference in the treatment of which lies

in the composition of the *enduit* especially (when working on plaster). No special explanations will, therefore, be given, except to point out the special method of flat painting to be made on these extensive surfaces, which consists in producing a granitic effect in the last coat, which must be kept more oily than an ordinary final coat, so that the granitic effect may be reproduced well, for with a coat of ordinary thickness, or laid on too dry, the grain formed in producing the granitic effect does not maintain itself, nor mark itself sufficiently. To obtain a good result the coat of paint [must be applied], and the production of the granitic effect produced thereon simultaneously. To do this, two men work together, the one painting, the other producing the granitic effect. On large areas they work in groups of four, two painting in front, and two producing the granitic effect behind; in this way, no going over again, no running is to be feared. The crossing of the coat must not be neglected, so as to spread it out well and render it of uniform thickness. A finer flat surface (*mat*) can be obtained by thickening the coat with one or two handfuls of white zinc in powder, which are incorporated and mixed properly with the brush. This is a turn of the wrist peculiar to painting with white zinc, for with white lead one can rest content with the liquid paint sufficiently thick at the outset. Its content of turps suffices to give the flat surface (*mat*) desired.

Varnished Paintwork.—There was formerly a style of enamel painting which had, as a point of resemblance with the subject of our explanations, that of having been done with white zinc alone, mixed with a white varnish [? dammar in turps], and that at a time when white zinc

was only a workshop curiosity. Now, forsaken for a long time, such paints fulfilled exactly the same rôle as the "enamel" paints of our time, but they were very dear both in cost price and in cost of application, for it required consummate skill to execute work of that kind, and it took much time. The work had the property [or defect] of lasting indefinitely. They need not here be referred to further (for the moment), because now they are almost completely abandoned, and replaced with advantage by the enamel paints just described; at the most, they survive on certain coach-painting jobs, and they may be utilised in a single instance in outdoor work, as will be seen later on. How can anyone say that the painter's trade is one of routine or rote. When attention is given to the matter, it is soon seen that it has altered its style of working in several ways. Rote always loses its powers before real progress, and each time that painters come across real progress in their path, they do not act the part of men of rote any more than any other handicraftsmen. Only real progress is very slow in this kind of thing, where confirmation by time that it is a real progress is absolutely indispensable. As to varnished painting, it is more than ever esteemed, and besides is greatly in use. In indoor work it is, however, less used than in outdoor work where it is quite indispensable, chiefly on woodwork. One can hardly see anything to be varnished indoors, except decorated work, imitation woods, and imitation marbles, or the smooth polishes when there are any, for they are out of fashion. In the same way as in varnish painting, and for the same reasons, all the undercoats should be prepared with little oil, the

only guarantee to obtain good results, both as regards beauty and durability. It would be superfluous to dilate further on the subject, since there is nothing new to point out in this operation, altogether a finishing one. Besides this is not, properly speaking, a general treatise on house-painting, but a special treatise on the modifications capable of being brought to bear on the common technique and practice incidental to the utilisation of white zinc as the sole basis of paints and the application of coats.

Waxed Paintwork or Encaustic.—This is not to be confused with wax-painting, which has nothing in common with waxed paintwork. Wax-painting is a style which, moreover, was never seriously used in house-painting, it was and still remains a method of artistic painting; at first greatly used in primitive times, it was afterwards completely replaced by oil-painting, and is now no more used than the dead languages which still exist but are no longer spoken. It is only practised, very exceptionally, by very rare adepts, on very rare occasions. But waxed paintwork has full sway in our professional customs, of which, however, it only constitutes a secondary operation, since it is simply paintwork with the usual foundation and executed as usual, the finishing alone of which is peculiar. That is simply an *encausticage*, that is a finishing off in encaustic replacing the varnishing, that is all. Wax or encaustic is applied only to pale *indoor paintwork*, preferably to white marble in vestibules or staircases, provided that these spots are closed, or sufficiently closed, that the outside air does not blow in hard at will. After the usual preparation and application of the coats

and the finishing of the decoration, when the whole is perfectly dry, the paintwork is coated not with white varnish, which is always prone to turn yellow and crack, but with a glaze of white wax, dissolved in turps and in the proportion of 2 to 2¼ lbs. of wax to the gallon of turps. This very simple operation is performed much more rapidly than varnishing, and only requires the care necessary to avoid blanks and thinly coated spaces. A good paint-brush should be used, soft and long in the silks, never, as far as possible, a new brush, owing to the hair becoming detached and remaining fixed on the paintwork. If a flat surface (*mat*) is desired it is left to dry, and kept in that condition. If it is desired, to obtain a brilliant surface, the next morning after its application a flannel rag is passed over the encaustic, of which neither the rôle nor the manner of working will be explained here, both of which every painter ought evidently to know.

Varnished paint on woodwork may also be waxed, either to render it quite flat or to render it lustrous after polishing the varnish. These, however, are operations which have neither in reality nor in good technique a serious importance, nor are they of absolute necessity. They are mere finishing touches, and should not be applied, except in earnest, for the application of wax on varnish, whilst it does not preserve the latter, renders the upkeep of the paintwork afterwards, more difficult, more complicated, more doubtful, for nothing can be done without first removing the wax, always a rough operation, which often takes off the paint as well, much further than intended.

OUTDOORS

Varnished Paintwork—Polished Varnish—Enamel Painting

Only the remarks strictly necessary for outdoor painting, having regard to its special character, will be given here, the greater number of the operations being similar to those described for indoor work; they only differ from them in a few points, important it is true, but with which white zinc has nothing to do. Taking outdoor woodwork in a prepared state, that is to say, covered with an *enduisage au maigre* (little oil), as has been explained, then pumiced, and stopped, or filled up, it should be coated with paint, the vehicles of which produce hard coats, for all the most general dark tints those most used for shop fronts, street doors, and coach entrances, which form the main types of outdoor woodwork; for all dark shades, deep blue, deep green, brown or black, white plays no rôle in the coat; for less dark tints, leather-coloured tones, tobacco tints,[1] or foundations for oak, chestnut, palisander, or mahogany, white only acts as an anodyne, about which we need not bother too much. The use of three thin coats on the outdoor *enduit* is not to load this foundation, which presents or ought to present, in itself, every guarantee of the durability of the foundation, and the less it is loaded with colour the less chance there will be of wrinkles and cracks; it is elementary technique, which must always be followed, as if it were a case of working with white lead. It is

[1] TRANSLATOR'S NOTE.—Chocolate.—TR.

evident that if the front door or the coach entrance which are to be painted do not first receive an *enduit*, but several coats of paint only, and then varnished,—it is evident that it will be necessary to use thicker coats, so as to line the pores of the wood; and to mark the grain and the veins, all objects which *enduisage* realises, at one stroke, and better than all the other cares bestowed on painting on wood; the *enduit* by its thickness, by its polish, and its hard composition, forms, therefore, the best of all foundations, and it is useless to overload it. On the contrary, only the strict minimum of thickness should be applied as paint, so as not to form wrinkles, which, becoming apparent under the varnish, take from the work all the stamp and all the character of fine work, whilst at the same time they necessitate extra pumicing. Therefore, on outdoor *enduits* only simple tint glazes should be applied, termed very improperly hard coats, only containing turps as a vehicle with a drop of varnish to fix it.

In the case of applying paler tints, where the use of white zinc becomes more important, it might be imagined that it would be necessary to modify the composition of the coat and to increase the oil somewhat to sustain the white zinc; it is not so, however, and the coat should always be kept lean (short of oil), because this coat, whatever it may be, will always be protected and maintained by the varnish. There is therefore no cause to fear the fragility of the white which serves as base; on the other hand, if the oil be increased, it would be to court all the annoying eventualities of that detestable system, which consists in benevolently storing up under the varnish a fatty liquid,

which owing to its final inevitable evaporation causes the paint to blister, or by the contraction which it exercises on the varnish causes it to crack, fissure, or become tacky, or even pitchy, full of marblings or dark spots. Now, in the case of real white, or almost white outdoor painting, on woodwork, recourse might be had to the old method of varnish (enamel) painting by mixing white zinc in powder with white varnish for outdoor work, if any such varnish can be found really fit for the work; if not, and even in simple doubt, it would be better to use squarely a varnish enamel, guaranteed for outdoor work, by the trade which prides itself in making several durable enough from this point of view. But in this case, as in the other, it is necessary to lay a foundation on the *enduit* with a flat white coat, poor in oil, so as only to apply the varnished paint or the enamel in the second place.

CHAPTER IV

PAINTING ON PLASTER, ON MORTAR, AND ON SOFT AND POROUS CEILINGS

Ordinary Outside Work, on House-Fronts, etc.

The practice usually followed in painting on plaster and other coated surfaces, or on soft and porous ceilings, is to feed the first coat of paint, strongly, with oil. The priming coat is, therefore, always kept very oily and very fluid, sometimes pure, or almost pure, oil. The object of this is to render the surface less absorbent for the other coats, and to forestall, as much as possible, the inevitable dark spots. But, with the use of zinc oxide as a paint basis, there is still another reason, which tends to favour oily coats for the painting of all outside surfaces. It has already been stated, in the preliminary remarks, that white zinc owes its comparative durability, solely, to the amount of oil which it contains when it is used as a paint. The principle of the oily condition is thus justified by two primordial reasons inattackable in practice—the first to fill up the surfaces, the second to impart greater durability to the zinc.

PRIMING OR FIRST COAT

The following are the amounts of zinc oxide, oil, and drier used for the priming coat on plaster:

TABLE VI.—*Showing the Composition of the Priming Coat on Plaster, in Painting with White Zinc in Oil.*

	In lbs.	In gals.
White zinc ordinary quality not superfine . . .	100	...
Oil	...	10
Drier	$2\frac{1}{2}-3$	...

The author strongly deprecates the use of turps, each addition of which, proportionately, decreases the oil, and courts the certain risk of having dark spots on the second coat, which may render it necessary to give a fourth coat, when only three are allowed for the work, whilst with a priming coat of pure oil this fear is almost nil. There is a certainty on sound plaster of having few or no dark spots, and one is sure of thus getting, from the second coat onwards, foundations already very lustrous, free from all kinds of spots, and requiring no effort of attention, nor any supplementary use of raw material; in fact, a priming coat of oil alone, mixed with stiff white zinc paint in oil, is the best preparation to give in view of the subsequent treatment, both from a practical and an economic point of view.

Filling up.—Harden the stiff white zinc paint in oil, with Paris white (whiting) as usual, but add a little drier;

allow to harden two days at least, to guard against dark or dull spots which insufficiently dry mastics or filling ups always produce on paint applied too hastily.

SECOND COAT

In this coat it is necessary to bring more solid matter to bear—more stiff white zinc paint, in oil, than in the priming coat. The second coat not requiring to be absorbed like the first, and its object being to leave on the plaster a thicker pellicle, capable of filling up, of levelling its pores, and of maintaining itself on the surface, without wrinkling or running,—we can in this second coat confine ourselves to the following proportions, by the reduction of about one-third by weight of the liquid composing the first coat:

TABLE VII.—*Showing the Composition of the Second Coat on Plaster, in Painting with White Zinc in Oil.*

	In lbs.	In gals.
Ground stiff white zinc paint in oil	100	...
Oil	70	$7\frac{1}{2}$
Drier	$3 - 3\frac{1}{2}$	...

In this formula it will be seen that turps does not figure, nor in the preceding one (Table VI.) because turps is injurious to white zinc, as it is to every lean paint (little oil) not protected by subsequent varnishing—that is to say, of every paint which ought to suffice in itself. But in applying an oily coat on another oily coat there is reason to fear the

wrinkling of the pellicle; there is thus reason, as in this case, to force the drier a little, the wrinkling being especially due to the slow drying of the pellicle—altogether to this cause, it should be said, because it includes all the others; but wrinkling is also produced by a quick-drying paint applied too thickly and insufficiently worked; the action of the air causes the surface to dry, but the interior of the mass does not dry so quickly. The coat then tends to run, but retained by the pellicle above it, it presses thereon and the whole shrivels up. A small amount of turps, 10 to 15 per cent. on the weight of the stiff paint, may be used, diminishing slightly the proportion of oil, which will hasten the oxidation of the mass; only, the same must not be done with the third coat. This latter ought always to be kept well bodied and oily, because it is on it that the destructive agents of every kind act directly, and, to resist them, the white zinc must needs be held together by oil alone.

THIRD COAT

Increase still further the solid ingredient by reducing still further the liquid portion of the formula of the second coat by about one-third.

TABLE VIII.—*Showing the Composition of the Third Coat on Plaster, etc., in Painting with White Zinc in Oil.*

	Lbs.	Gallons.
Ground stiff white zinc paint in oil	100	...
Oil	47	5
Drier	3 - 3½	...

Using these proportions, the painter will be certain of doing work which, from the second coat, will have no weak points, no dark patches, nor spots of any kind, whilst the third coat will present all desired brilliancy and opacity. However, there are plasters and plasters, and from the difference in their nature and method of application, and their situation, unforeseen mishaps may follow each other, against which it is advisable to guard by previous examination of the materials which are to be painted, so as to ascertain exactly on what one is going to work and to where it may lead. The proportions given above for the three classical coats on plaster were those used by the author for special comparative trials working normally on fronts (façades). The results have shown that the proportions were absolutely rational. The author used for this class of work, where durability must rank first before everything else, not the superior brand of white zinc, as should be used in fine indoor work, but a somewhat more crude white zinc, a naturally plumbiferous one, which appeared from that fact one to be more suitable, as regards durability and covering power. Paintwork jobs were thus finished with three coats only, which could, and can, bear comparison with other surfaces of the same nature and painted similarly by the author with *white lead.* It is not pretended to be asserted that white zinc, even plumbiferous white zinc paint, will behave better in the future than white lead paint, but, according to the manner it has behaved since its application, it may be believed that it will yield on this occasion the maximum of resistance possible for a white zinc paint to attain. Now the author does not want to demonstrate anything further. This treatise on

white zinc is not written with the object of pitting white zinc against white lead, but to show the methods of utilising it in the best conditions possible of durability and rational application.

The "Enduisage" of Plaster.—The great porosity of plaster led painters to treat it quite specially, and very expeditiously, in preparing it for painting. The custom adopted, and which gives excellent results, is *enduisage au gras* [that is the application of an *enduit* in which the proportion of oil is a maximum]. This operation consists in the *enduisage* of the plaster in its crude state, directly, and without previous coat. The only preliminary operation (after the obligatory dry rubbing down) is a rough stopping, or filling up, on the raw plaster called slaked plaster. It has been said that this filling up was rough, and it is so as a matter of fact, for it is only to fill up the too deep or too wide holes which the *enduit* cannot, in the first instance, span or level; and if a mastic of special composition be used, it is because the surface of the plaster must not be oiled anywhere. The *enduit* would in fact roll on the oily portion, and even on too smooth filling up. Hence it is that fine plaster, termed modelling plaster, is not used for this purpose, its fineness yielding too smooth a filling up, not porous enough to fix the *enduit*. That is why on a very uniform and absolutely smooth ceiling an *enduit* cannot be applied even on the raw plaster. Ordinary plaster mixed and slaked affords a stopping, or filling up, as porous and absorbent as the surface which is filled up, itself, since both are identical.

By using white lead, *enduisage* is a common operation, and comparatively easy, but when white zinc is used, it

becomes, especially in certain cases, a most difficult operation ; it is, in fact, the most stubborn operation, in its exclusive use, as well as the operation which, in using zinc oxide, affords the least guarantee of durability, and it is mainly here that the painter must change his method of working both as regards composition of his raw material and in the method of application. But, with attention and care, it is possible to compose *enduits* with white zinc, affording sufficient guarantees, in these two respects except as regards hardening (drying hard), which always takes much longer with white zinc. Another defect of white zinc is, that it sinks into the hollows—it does not hold itself together like a white lead *enduit* ; then, in applying it, it drags on the knife, just as in painting it drags on the brush, which well demonstrates its want of suppleness, compared against the suppleness and the mellowness of white lead. Here therefore, are two annoyances, two drawbacks, which must be expected, and which must be overcome as far as possible. To do that, it is necessary to find the proportions of the most flowing mixture to use, and which at the same time is sufficiently resistant to sinking.

As regards the point under discussion, namely, oily *enduits* on raw plaster, the difference in the turn of the wrist, or in the composition, is not so great ; it only requires a few attempts, a few experiments, to grasp these differences. The author, as far as he is concerned, advises for this use of oily *enduit*, what he has already advised for outdoor painting on plaster—the use of common zinc oxide —a plumbiferous zinc oxide, if possible, in preference to a superior quality, a perfectly pure zinc oxide, for the former

will far better than the latter produce an *enduit* both more elastic and more durable, and also—which is not to be despised—more economical.

The proportions of the mixing for this kind of *enduit* may be given as:

TABLE IX.—*Showing the Composition of a White Zinc Enduit on Raw Plaster.*

	Lbs.
Ground stiff white zinc paint in oil . .	100
Paris white sifted very fine . . .	200
Oil sufficient to bring mixture to consistency to work under knife	

The Paris white (levigated chalk) is used in about twice the proportion by weight of the stiff white zinc paint in oil, say 1 lb. of stiff white zinc paint to 2 lbs. of whiting (Paris white). The stiff white zinc paint is thinned with linseed oil to form a strong-bodied paint, then the given amount of Paris white is incorporated in powder, but not all at once, in two or three proportions, stirring well after each addition to mix it intimately and break up the lumps. When all the Paris white is mixed in this way with the paint, previously made with white zinc, a very consistent paste should be obtained, but easily applied by the knife. It is tried before commencing work, and the proportions are corrected, if need be, by a slight addition of oil, if it is too stiff to spread; or by Paris white if it is very soft. Drier is added, pre-

ferably liquid drier, about 2 oz. per 100 oz. of *enduit*, both by weight.

As to the application proper, or *enduisage*, we must expect to find less suppleness on the part of the white zinc *enduit*, compared against the white lead *enduit*. It must, therefore, be worked more with the knife so as to spread it properly, but that is not a very great difficulty, and it has been pointed out, as a more serious matter, in the case of lean *enduits* (short in oil) in the chapter dealing with fine indoor painting. The oily white zinc *enduit*, made with requisite care, behaves on raw plaster in almost the same way as the oily white lead *enduit*, and its application does not give rise to such appreciable differences as the application of the lean *enduit*; and although the author is more than ever convinced of the superiority of white lead, both as an *enduit* and as a paint, owing to the ease of application, the much more rapid hardening, and the greater durability which it imparts to them, he readily acknowledges that his personal, specially conducted, experiments have led him to abandon some of his prejudices, and not the least of them, against white zinc.

Economical or Gooseskin "Enduit."—On raw plaster there is much used for ordinary work, with a view to rapidity, so as to render the plaster uniform, and to dispense with a priming coat as well as filling up, always an excessively big job, a substitute for an *enduit*, economical and of good quality, generally termed *ratissage*; it is simply Paris white (levigated and finely sifted) mixed with linseed oil to the consistency of putty. There is sometimes added a little stiff white lead paint, to impart binding

and flowing properties, but most often this addition is neglected, and replaced sometimes . . . by soft soap . . . to make it glide ! ! !

That is a vile trick which, like many others of the same kind, has been begotten by *piecework*. Fortunately, this trick is not general, and the real gooseskin (molleton), which is only in reality common putty, somewhat softened so as to be applied by the knife on the walls, is of very appreciable service. It furnishes a very suitable and efficient preparation coat on common work. It is a classical operation, which white lead prohibition cannot prejudice nor discountenance, and it will long continue in common use. It would not have been referred to here if it were not to point out two facts, interesting to the new technique, which the obligatory use of white zinc is about to create in all paint and *enduisage* work. By its composition alone, the gooseskin *enduit* or the *enduit* for rubbing down is naturally liable to produce numerous dark spots, after the application of the first coat, which it does not absorb uniformly. This mishap must be guarded against in the preparation of the coats which are to cover it, beginning always with an oily coat to nourish it, and terminating with a semi-oily but well-bodied coat—this in the case of uniform tints. Where there is decoration, as in vestibules and staircases, the last foundation coat must be kept rather short of oil so as to have an under-surface to act as a background, to the glaze of the decoration, especially in imitation woods.

But as in the case of the first coat, on *enduits* in general, there is no occasion to depart from the normal proportions used in common practice, say :

TABLE X.—*Showing the Composition of the First Coat on Gooseskin "Enduit" ("enduit" for rubbing down).*

	Lbs.	In gals.
Stiff white zinc paint in oil .	100	...
Oil	46	5
Turps	20	$2\frac{1}{2}$
Drier.	2 – 3	...

These proportions may be repeated, as near as may be, for the second coat in common painting. As to the second coat to be applied on the *enduit*, in the case of painting in uniform tint, as undercoat for enamel work, or as an undercoat for decorated marble, the amount of turps must be increased so as to get a firm, almost flat, undercoat. This proportion may be got by equal amounts of the two liquids, say as follows:

TABLE XI.—*Showing the Composition of the Second Coat to be given on an "Enduit" on Plaster, and to serve as the Undercoat for an Enamel Paint or for Decorated Marble.*

	In lbs.	In gals.
Ground stiff zinc white in oil .	100	...
Oil (about)	28	$3\frac{1}{3}$
Turps	...	$3\frac{1}{3}$
Drier	2–$2\frac{1}{2}$	...

For decorated marble the coat of glaze must not be applied, directly on the first coat, but the glaze, as the principles of good technique require, must be applied, on a second coat—that of the last formula given. In graining

or painting in imitation of different woods, the foundation may be painted from the first coat in an approximative tint, and in the second coat in the definite foundation tint. Rather more turps must then be added than oil, so as to avoid any possible greasiness, and thus prepare a favourable surface for good varnishing. Great care must be taken to let the decorative work dry well, before varnishing it. This remark, which is not sufficiently attended to, applies particularly to oil-glaze; water-glaze, on the contrary, requires to be varnished immediately after execution. For extra-lustrous paintwork, in uniform tints, made by the superposition of an enamel paint of some sort, reference is made as to what has been said on the subject in the chapter on indoor painting, on woodwork; but an important remark may be added, which has been omitted, and that is never to apply an enamel paint, except in a mild atmosphere, neither during cold weather nor on cold surfaces, and still less in violent currents of air, which ought to be prevented, cost what it may, during the whole course of the application of the paint, and until perfectly dry. This precaution may be troublesome in certain cases, but it is indispensable to the success of this class of work.

For paintwork of uniform tint, which it is desired to render lustrous by Dutch oil (Stand Oil), see likewise the observations and remarks thereanent in the same chapter.

Economical Indoor Paintwork by the Use of Good-Quality Lithopone

In the course of the present examination, it has been said that there was white zinc and white zinc. The

same remark applies equally well to lithopone, for this product, which has some good qualities whatever else may be said against it, has been outrageously faked up and adulterated, and such vile mixtures put on the market, under this name or under names which hide its commercial origin, that one can well believe, with every appearance of justice, that there is no good lithopone. That is, however, an error, as will be shown. There are, in fact, lithopones and lithopones; the real product is the result of a chemical combination, formed by two mineral salts, zinc sulphide and barium sulphate. The true lithopone is, therefore, what is called in chemistry a double salt. In this method of rational manufacture, the two constituent elements are obtained, simultaneously, in the same process. Their molecules are generated together, and form a molecular whole, completely inseparable in mixtures from the liquids with which it is mixed to make it into paint.[1]

But in the other false, irrational method, which, for feelings of shame, we cannot term a commercial method,

[1] TRANSLATOR'S NOTE.—A double salt is by no means formed every time that two solutions are added to each other in molecular proportions to precipitate themselves as *mixtures* of two inorganic solid substances in molecular proportions. Alum is a *true* double salt (sulphate of alumina and sulphate of potash), which *crystallises* in cubes and octahedrons. Lithopone is an *amorphous* mixture, and no sophistry can make anything else of it. The zinc sulphide retains all its bad qualities, which are merely reduced by so much precipitated barytes. But this reduction does not prevent the zinc sulphide and free sulphur from vulcanising the oil and rusting iron, and carrying out the whole cycle of detrimental work engendered by lithopone to the full, due to the fact that zinc sulphide acts on oil, and like all sulphides is unstable and so generates sulphates which act on iron.

these two mineral salts, obtained separately, are ingeniously mixed in certain proportions. The product, therefore, is not the result of a chemical combination, as in the first case it is a vulgar mixture of two substances, the molecules of which are in no way amalgamated together, but simply bound together by the liquid which serves as vehicle to the paint; now this alliance is more ephemeral still as the barium sulphate introduced is in the natural state and crystalline, therefore very liable to be precipitated (from the vehicle); these molecules, heavier than the molecules of the zinc salt with which they are mixed, separate inevitably by precipitation; and there is thus only utilised a hybrid, heterogeneous product, without any cohesion, with no affinity for oil—in a word, a product absolutely inert, which the best of binders can never bind together.[1]

Such is the summary explanation of the bad results originally obtained with lithopone, which had invaded the French market more than any other, owing to the eventuality, which exists in France, of not being able to use white lead in any kind of paintwork any longer. As in the case of white zinc, the author has made comparative trials, which have demonstrated to him that,

[1] TRANSLATOR'S NOTE.—It would be quite easy to substitute *terra alba* (gypsum) for barytes, and thus obviate some of the author's objections to natural barytes, which, however finely ground in oil, always grates on glass under the palette knife, so that 5 per cent. may be readily detected in that way. Why not use blanc fixe? There is not enough of it to go round unless specially made for the purpose, and then one might as well make lithopone at the outset. Barytes being stable and inert, at least gives the oil a chance to perform its functions as a binder. It does not vulcanise it so that the paint crumbles away. The affinity of the zinc sulphide constituent for oil is only too great.

with genuine lithopone, very good paintwork could be executed at least for indoor work. Although certain outdoor trials gave very fair results, the author does not wish to take the responsibility of recommending lithopone, even molecular, for work exposed to the weather, which moreover would be, theoretically, contrary to scientific data. Its average consumption, per square metre, as a second coat, does not exceed 80 grms. per square metre (say 1227 grains for 1600 square inches), whilst the most devoted partisans of white zinc estimate the average consumption thereof for the same purpose as 110 to 120 grms. (say up to 50 per cent. more).

Good lithopone, moreover, has the advantage of being a dazzling white, much superior to superfine white zincs. It covers amply in three coats, adheres and hardens in a very normal manner. As to its durability in the interior, one may give it, according to searching tests, several years of perfect adherence—four or five at the lowest. The author had, personally, avowed prejudices against all lithopones in general, owing to what has just been said concerning the bad results which they gave at the time they intruded into the French markets and workshops ; but, as he has already acknowledged, in regard to certain of his prejudices against white zinc, which he has abandoned without any regret, owing to the results of certain of his experiments, he has been able to acknowledge that, with lithopone resulting from the chemical combination, explained at the beginning of this chapter, it is very possible to execute fine and good paintwork, at least for indoors. It may be used alone for whites, or tinted to any desired hue. It may also be used as the second or third coat

after a good priming coat, with an ordinary brand of zinc oxide, less white but more durable than the superior brands.

However, it can yield, by itself alone, very fair results in three coats. Moreover, it may be sustained and protected by a wax encaustic, or by some sort of varnish, absolutely identical with what is used to protect white zinc, in cases determined by the usual practice for such class of work.

The following may be given as the proportions for the coats applied in painting with lithopone:

TABLE XII.—*Showing the Composition of the Second Coat used in Indoor Painting with Lithopone.*

	In lbs.	In gals.
Stiff lithopone paint in oil .	100	...
Oil	24	$2\frac{1}{2}$
Turps	10	$1\frac{1}{4}$
Driers	$2\frac{1}{2}-3$	...

TABLE XIII.—*Showing the Composition of the Liquid Paint used for Third Coat in Indoor Painting with Lithopone.*

	Lbs.	Gals.
Stiff lithopone paint in oil .	100	...
Oil	22	$2\frac{1}{2}$
Turps . . .	5	$\frac{5}{8}$
Driers . . .	$3-3\frac{1}{2}$	...

These two formulæ give a semi-lustrous paint, which may be rendered lustrous, by a suitable proportion of stand oil (Dutch oil), added to the liquid paint, after it is made, and in the proportion of about 3 per cent. It is well not to use too much of this oil, the results of which, as regards brilliancy, are not always those hoped for, and which possesses, moreover, a very marked tendency to cause the paint to run and descend.

On the subject of lithopone, and its use in painting, this is what the author wrote, in a paint merchants' journal which desired to have his views after certain experiments he had made, as to what he thought good or bad of this product.

"Lithopone is a hybrid product, a compound of two substances; speaking chemically it is a double salt (salt of zinc and salt of barium) the combination of which may be obtained in various ways—(1) in a scientific manner by rational manufacture, (2) in an empirical rule-of-thumb manner by grinding and irrational mixture. Now, it is to the method of manufacture used that its good or bad qualities are due, and not to the nature of its elements [*sic*].

"In the rational method of manufacture, the two metallic salts, zinc sulphide and barium sulphate, are obtained simultaneously; they are born together, it may be said, and are the result of a chemical combination; their respective molecules, born simultaneously, are in a state of perfect aggregation. They form a molecular whole, intimately bound together, and the elements of which are therefore inseparable in the mixed liquids in which they are incorporated to form paint" [*sic*].

In the empirical method which the author terms irrational, unscientific, and purely commercial, it is not so; in fact, even if it is made from the same two elements (the two metallic salts already quoted), the state of aggregation of the lithopone is quite different, the respective molecules of these two salts remain chemically separated; it is only, in fact, an artificial reconstitution, the result of which can only furnish a product which will behave quite differently from the product obtained scientifically, and chemically the barium sulphate exists by this method in the natural state in the lithopone, that is to say crystallised, therefore inevitably precipitable, fatally separable, from every mixture and from every liquid which may serve as binder; it is INERTIA in every acceptation of the word.[1]

This short explanation suffices to demonstrate that there are good and bad lithopones; the misfortune for painters

[1] TRANSLATOR'S NOTE.—The author's premises are not so sound as to the uninitiated they may at first sight appear. It is to some extent a mere question of fineness of grinding, first in the dry and then in oil; and if the zinc sulphide be precipitated on to ground natural barytes that will pass through a 120-mesh sieve there will not be much difference between the two kinds of lithopone after due care in grinding in oil. But if coarse natural barytes and zinc sulphide be dry mixed, and the result badly ground in oil, the conditions indicated by the author may supervene. Again, to describe ground natural barytes as crystallised is to distort facts. Barytes used as a pigment is mostly massive; and, moreover, finely pulverised crystals after pulverisation are by no means crystallised. It is a scientific or theoretical fallacy that the ultimate particle of a crystal is still a crystal (at least when a crushing as distinct from a splitting force comes into play). The bad effects of lithopone, as distinct from other paints, are due solely to its composition. With coarse barytes friction of grinding will start vulcanisation of the oil at the outset, and herein possibly lies the key to the difference between the "molecular" lithopone and its more artificial substitute.

is, that in the beginning of the campaign against white lead, the French market was invaded by German lithopone mostly of rule-of-thumb manufacture, common mixtures of zinc sulphide and crystallised [*sic*] barium sulphate. On the faith of prospectuses and on the bounce of brokers these substitutes were utilised—all declared more or less SUPERIOR to white lead!!!

Even now, is it not so still? They still strive to convince painters *that they know nothing of painting*; travellers strut about in front of the master painter to whom they talk in a language enamelled with sonorous scientific words. They develop a new theory, plausible in the extreme for their product, which invariably always *covers more*, *lasts longer*, and runs *cheaper*, because . . . here the special theory comes in and demonstrations of A + B, explanations on densities, volumes, comparative weights, and quantities used. Oh, these fine gentlemen are so clever, and when the painter risks a remark they reply to him with a cunning leer, "But you do not grasp the point, you do not understand, you do not know." They even go so far as to show him how to make his liquid paints and apply his coats. In fact, as far as these theoretical men are concerned, the practical man does not count, he can only allow himself to be led. Ah well, at the end of the campaign against white lead, painters had let themselves be led too far; they utilised everything that was offered them *to replace white lead with advantage*, and executed paintwork with lithopone with confidence. That was for many a sad experience.

Painting on house-fronts was seen to yellow or blacken in three or four weeks, others ran down outrageously,

some shelled off, and almost all turned dead and grinned unmercifully in spite of the three regulation coats. The results were pitiful. So lithopone was denounced, lost esteem, lost everything in the mind of the painter. Dealers were obliged to resort to pretentious, pompous names, under which droll disguise they tried even to get their lithopones to pass muster. But it was all of little or no avail. Painters went back to white lead or sought good white zincs with the simple name of oxide, free from any admixture, and by these means they attended much better to their interests as well as their reputation.

But every decision may be revised; no one condemns without appeal; moreover, it is to favour this revision, and to make this appeal understood, that the author has commenced by explaining what lithopone really was, and what it was not.

It is always profitable to examine new products, practically, if it were only to find in them one good quality. One thing is certain, and here the author speaks from experience, the so-called molecular lithopone, chemically combined, [*sic*] is adapted for painting, to the same extent and in the same conditions as white zinc, except for outdoor work, for which the latter is best adapted. It is not pretended to pit lithopone, even molecular, against white lead or even against white zinc. It must only be asked to do what it can do. Now, the author can assert, from his personal experience, that molecular lithopone can, owing to its state of aggregation, to its highly pronounced covering capacity, and to its facility of extension, yield indoors very fair paintwork, very beautiful in appearance and of normal durability.

It can even serve as a basis for economical work, because owing to its covering capacity it may be employed very thin, its consumption in the second and third coats not exceeding 65 grammes of liquid paint per square metre, whilst white zinc always exceeds 100 grammes under the same conditions. At first sight lithopone ground in oil does not look well, it seems to want body and to throw out its oil, but once prepared as a liquid paint by rational mixings it behaves as well as may be desired. Evidently it has not the properties of white lead, as regards mellowness and adherence. But neither has it the practical drawbacks of white zinc, over which it scores as regards covering power, drying, and hardening; as to its whiteness it can be compared with those of the most beautiful whites of another nature.

CHAPTER V

HINTS ON PAINTING WITH WHITE ZINC

Remarks on Relative Proportion of Ingredients

It is advisable and even necessary to remark, as regards proportions, the absolute exactness of the formulæ given cannot be guaranteed to those who wish to make them up again from the formula. It is quite a material impossibility, due to inevitable causes, and independent of the goodwill of every one. In the first place, the difference in density may be quoted, and also the difference in the firmness or consistency of the stiff paints ground in oil sold to the painter. The density of the same pigment, especially white zinc, varies according to the quality or the category of the oxide obtained in the factory, the heaviest being deposited in the first condensation chambers, and the lightest going on to deposit itself in those furthest away, where its lesser density entrains it. The same operation therefore produces white zinc of different densities, and it will thus be still better understood, that different methods of manufacture may produce somewhat variable densities, between the zinc oxides of different firms. Now, according as the proportions have been made up, from a white zinc of a given character, the making up

again of the paint from this formula cannot be rigorously exact, unless the second operator uses the same kind of white zinc. To this first difficulty, there must be added the difference in stiffness in the stiff paints, in oil, ground in the factory, which varies, not only between the products of different manufacturers, but also with the same product of the same firm, according to the state of the atmosphere, or the alternations of heat and cold undergone by the stiff paints after packing in barrels and storing, alternations which may, in certain cases, cause the paint to string or to harden. It thus varies in consistence, becoming more thin or more thick. In both cases, the exactness in making up the paint again can only be relative.

Moreover, if we take into account that certain middlemen do their own grinding, where rapidity is more important than care, and that, further, they make special mixtures to be sold cheap, and that they thus deliver products of a more or less questionable composition—all that may exercise a certain influence on the results from a given formula, and thus spoil to a certain extent the composition of the liquid paints made from it.

But there is no need to exaggerate the fears, nor the importance of these possible errors; the discrepancies are always minimum when first-hand products are used. The important point in the formula is *the* ratio, between the proportions, between the different elements :—(1) Between the oil and the stiff paint; (2) between the turps and the stiff paint; (3) between the oil and the turps. That is what must be looked to above everything, because it alone is invariable in the composition of a normal product. In

addition to these remarks it must also be stated, that if, in this treatise, formulæ are only given for three coats, that is not to say that three coats always suffice—far from that; but, as a French professional, the author has had—in this treatise, more especially intended for French painters, who are about to be compelled by law to abandon the use of white lead, and consequently forced to use white zinc—necessarily to conform to French practice, which in a general way only comprises three coats. The fourth coat, with white zinc, in France is ALWAYS *exceptional*, whilst everywhere else, and especially with our neighbours in the north, the Belgians and the Dutch, THE FOURTH COAT IS GIVEN REGULARLY, often even it is followed by a fifth, without the inspectors being at all dazzled. All the coats given are recognised and paid for, their number is not disputed except when there is a contrary and a previous agreement. But it is not so in France; three coats are allowed, and no more, whether it be white zinc or white lead; tradition is there—sacred, intangible, immovable. Neither Directors of Works nor specifications bring any change to this state of affairs, and there are even loud outcries when a painter ventures to reserve his responsibility, or if he proposes an eventual supplementary coat. Is the French abnormal practice not going to change? Is it not desirable in any case that it should? For that to occur, the painters of France, after the example of their good colleagues, Belgian and Dutch, must resolutely bind themselves to the fundamental principles of the trade, and categorically declare, that if in certain cases four coats of white lead paint are sometimes necessary, these four coats become indispensable,

as soon as it is a case of painting with white zinc, and they may be regarded as being a minimum for all work of a serious nature, for it must be said, and repeated, that this number of coats, for the style of painting now under consideration, is RATIONAL and not exceptional.

N.B.—Since the proportions are established, according to the regular custom of three coats, it will suffice to conform to rational practice; in cases where there is liberty to apply four coats, it will suffice to keep the two last of equal and similar fluidity by increasing a little the proportion of liquid indicated for No. 3 Coat, or again to mix them from the same formula as No. 2, thus giving three successive and similar coats on the priming, which would absolutely cause nothing at all abnormal in the result to be attained in the paintwork.

The Knack of Painting with White Zinc

The manner of painting with liquid white zinc paint differs from the common method of painting with liquid white lead paints, the latter, whatever any one may say, being more flowing, more mellow, and much more adhesive and cohesive. It has been seen that the constant prepossession of the exclusive partisans of white zinc is to recommend thicker coats than with white lead; therefore the use of thicker coats may be regarded as one of the necessities, an obligation connected with the use of white zinc, and one that already furnishes the first drawback to the common method, which must therefore be modified, however much it increases the defect of elasticity or unctuosity, which renders the method of spreading the paint

more difficult. The brush must be charged more often, and more cross-working done, to cover well and smooth it down properly. It must, therefore, be borne in mind, that the turn of the wrist cannot be the same as in painting with a white lead basis kept constantly thin and always very flowing. One must, therefore, expect with a white zinc paint to feel less facility of execution in the hand, to spread the coat; and afterwards, in equalising it, to render the paint uniform.

When, for example, a room door is being painted, it will at once be seen that the corners or angles of the panels are covered with difficulty, the edges and rounds of mouldings seem to impoverish themselves under the passage of the brush, in spite of the lightness of this last smoothing touch. It is also seen that the grooves have a tendency to get choked up. It will be objected that these are slight annoyances; there is no doubt about it. But these annoyances do not occur with white lead, because, kept more fluid it does not choke up, and with greater covering power and a tendency to dry it hides perfectly the edges and the projecting rounds of mouldings.

These slight annoyances, it may at once be declared, are far from forming insurmountable difficulties, but they provoke the painter, who cannot get on as he would like; and what unnerves him still further is, that he takes into account the greatly increased time and attention which he is forced to bring to bear to a task hitherto accomplished with ease and facility. He has, in fact, the sensation of not doing what he ought to do; above all, of doing worse work, in spite of all the care he brings to bear on it.

This, irrefutably, shows that the manner of working white zinc is not the same as the manner of working white lead; but, to go further, when a coat of white lead is applied and crossed normally, simply across and up and down, the hair-strokes left by the brush disappear almost at once, the coat equalises itself of its own accord. When white zinc is spread, the coat has always a tendency to show hair-strokes; in spite of normal crossing up and down and across, it does not become equalised, except by dint of going over it again, smoothing it, and resmoothing it, to lay the hair-strokes; also, whatever may be asserted, white zinc does not, by any manner of means, adhere and cohere like white lead; the painter alone can redeem this defect, and it is incumbent on him to do so by a lighter turn of the wrist, by more sustained attention, by greater care. Smoothing should be done repeatedly and with particular care; it is, moreover, what must be done in the future, if it be desired to submit intelligently to the obligation to use white zinc and to execute proper work with it.

Certain practical men may, however, object that they have often wrought with white zinc and have never perceived the differences pointed out here. To this it may be replied that, in France, up to now, mixtures of white lead and white zinc have been more used than white zinc alone, which causes many painters to believe, in good faith, that they have used the genuine product, whilst in reality their liquid paints were more plumbic than zincic. It may be affirmed without fear of error that during the last few years, for every 100 cases of so-called white zinc paints, there were 98 into which white lead entered to the

extent of one-half, if not three-quarters [!] It is a fact which is notorious in the profession, and of which typical examples might be quoted, especially that of the chief chemist, a high-placed official who had his official laboratory repainted, under the express condition that only white zinc should be used, which was formally promised him; but in the course of the work the learned Professor, wishing to satisfy himself as to the composition of his paint, surreptitiously lifted a certain amount, which he analysed, and found it to contain 85 per cent. of white lead.[1] Ah well, to reply to the objection just raised it is evident that the working painters who wrought with this paint had no knowledge of its real composition, and all of them believed that they were using white zinc alone. Their opinion of this paint would arise from that ignorance, and they would be able to declare, in all good faith, that white zinc paint wrought as well as white lead paint.

Observations of a different nature may, however, be brought to bear. The author has personally seen, during the course of work executed by gangs of painters, working together, certain of them growl and grunt against the liquid paints which the foreman gave them to use; these liquid paints appeared thick to them, muddy, of poor covering power; they showed hair-strokes outrageously, and required laborious smoothing, with the flat brush. The difficulty was undeniable, but they did not know exactly to what to attribute it. Ah well, it was simply white zinc liquid paint used,

[1] The ideal laboratory paint has yet to be discovered. Zinc oxide forms zinc chloride with HCl fumes, and open steam condensing brings this zinc chloride in contact with the skin and hair of the operators. Besides, even a 2 per cent. leaded zinc blackens as bad as white lead itself with H_2S gas.

as an extraordinary fact, almost alone, or according to formal orders ; only, the painters had not been informed of the change in the composition of their paint, the defects in the use of which they could not fail to find out by the ordinary means and ordinary practices. Is not this another proof that white zinc does not behave like white lead in purely manual execution ? There is no need to hide the truth ; it is much better to declare it outright, as is done here, that the turn of the wrist, as much, moreover, as the preparation of the liquid paints, are different, according to whether white zinc or white lead is to be used. This point will not be dwelt upon further. It is necessary to pass on to explanations of another order, for it is desired that this instruction on white zinc be complete, both from a practical and a technical point of view, which is the only way of rendering it profitable to the author's colleagues, who, less favourably placed than himself, are not in a position to make observations nor to draw the conclusions which he has been able to do, after the comparative trials made by him on these two everlastingly rival paints.

CHAPTER VI

TESTING COMMERCIAL ZINC WHITES

The Covering Power of Pigments and Paints

Without saying anything against the agencies connected with modern industry, to advertise and distribute its products, one cannot accept, as the words of the Gospel, the more or less convincing assertions of brokers, travellers, and representatives, regarding the merchandise they offer for sale. Every one knows that the method of scoring a point, and insisting upon it, goes a long way towards the comparative success of a given product. These gentlemen cannot be blamed for their methods. The greater number of them have a wonderful talent for disconcerting pertinacity. It is, however, only just and logical to discount heavily the wonderful qualities which each new product presented for our approval undoubtedly possesses. Those interested, namely painters, cannot be too strongly urged, above all things else, to test for themselves, in a comparative manner, each new product which is submitted to them, against those which they are already using, or against similar products upon which they are also called to decide. These tests are neither difficult nor long, and when one will take the trouble to perform them, the

time can always be found. Besides, it is to the painter's own interest that he should so act. The conclusive and comparatively easy experiments, about to be described, are taken from those used by the author on white zincs, the results of which are given in this small manual.

To assess, in a sane manner, a raw material for painting, for all the properties which it is capable of possessing, it must be examined under the different heads of (1) Economy; (2) Ease of Application; (3) Covering Power (opacity); (4) Durability, as well as (5) General Appearance, after the work is finished.

1. *Economy.*—In addition to its cost price, the economical side of a pigment is shown by the greater or less amount of liquid which it requires to be brought to a condition of normal fluidity.

2. *Ease of Application.*—The practical side of the question is estimated by the ease of application, and especially the tension, disappearance of hair-strokes, by the less time it takes in drying, and by the degree of hardness.

3. *Covering Power.*—By the greater opacity, or greater facility in a state of normal fluidity, the coat being kept somewhat thin, of masking the under surface.

4. *Durability* is estimated by the least total change, in appearance, under the influences of the weather, and alternate lowering or elevation of temperature. This property, the importance of which is great, cannot unfortunately be determined in a positive and absolute manner, except after a great lapse of time, five to six years at the most; nevertheless, it may be estimated to a

nicety by certain methods which will be described forthwith.

5. *Appearance.*—The beauty side of paintwork may be judged forthwith, but the decision should also be confirmed by time.

Notwithstanding these different points of view, they can all be combined together in one experiment, to test similar products simultaneously. For this purpose, a large piece of dressed wood or a large panel is taken and painted uniformly of a grey, brown, or green colour, of a comparatively dark tone. This panel ought to be a good-sized one. It is afterwards divided, by vertical lines, according to the number of tests to be applied, and after the style of the divisions of the panel of a wall, but excluding squares, for the divisions must be in juxtaposition, that is, side by side, touching each other.

These divisions ought to have a minimum surface of 0·25 to 0·30 cm. in width by 0·60 to 0·70 cm. in height, if it be intended to operate in a serious and rational manner.[1] The author has found that the system of small pieces of sample work do not give the necessary guarantees for safe conclusions. Each division represents the experimental field for one colour, for a given white, on which the three traditional coats, are applied. Each coat should be kept at the normal fluidity, and this fluidity must be identical, in the case of each pigment tested. In each case, the painting is begun a little lower down, so as to leave the upper part in the condition of the previous coat;

[1] TRANSLATOR'S NOTE.—To operate in a serious and rational manner the author should have multiplied his dimensions by 100. This was evidently the dimensions he intended to use, or actually did use, say 10–12 inches by 24–28 inches.

that is to say, the priming coat, when the first coat of white is applied, so as to show the nature and the value of the foundation tint, the function of which is to cover; then in the condition of the first coat, when the painter passes on to the second coat; finally, in the condition of the second coat, when the painter passes on to the third coat, thus gradually descending the painted surface. The latter will then show vertical spaces, showing bands of paint in successive layers, in horizontal lines, at different levels. In this way we can readily see the exact appearance assumed by the paints tested, as they are laid on one above another, thus enabling their general properties to be assessed, and in time their special properties. If it be desired to proceed to more searching tests still, on the subject of covering power of the pigments to be tested, a large strip is painted on the priming coat, which in this case may be kept less dark in tone. This strip is a well-fed tone of dark green or deep brown-red; then above these bands, of the same well-fed tone, the three successive coats are applied over the whole width of the division, as already described. We can then assess with absolute safety the covering power of each white tested, as well as its degree of whiteness. Its covering capacity will be seen in the first, second, and third coats; and it may be remarked that the pigment which appears to cover best in the beginning is not always the one which covers best in the end. Again, differences may be found in the uniformity of the covering power of each product. Remarks which are all a little surprising but very real, and which prove how necessary it is to make repeated observations, to ascertain,

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very exactly, the respective virtues of pigments—of pigments used as a basis for paint.

The real covering power is only developed after a certain lapse of time, and not forthwith. It takes at least twelve hours to see whether a pigment *grins*, or does not *grin*. The expression *grin* is quite technical, and denotes the striking back or visibility of a dark tint under a pale one. The uniformity of the coating shows a homogeneous paint, which coheres well after its application. A paint which in the first coat appears to cover less than another, and which in the second coat excels the latter, shows that it has a more compact texture, and fixes itself better because it sustains itself, and prevents the undercoat from striking back, whilst the pigment which still *grins* in the second or the third coat is inferior as regards opacity, and shows that it must be applied thicker than that against which it is compared. This is what always occurs with good-quality white lead; when contrasted with good-quality white zinc it appears to cover less in the beginning; but from the second coat it gains a decisive advantage which it permanently retains over the latter, especially as regards uniformity.

Some one may say, that is for wood, but what will happen on plaster or other coatings for walls and ceilings? There, evidently, direct experiments must be made on these materials, and it is not quite so practical, on account of the scaffolding which must be found. But it will be readily understood, after making the above experiments, that it is easy to ascertain the exact qualities of a pigment, qualities which will remain the same on any other object, the more so, as the experiments just indicated would be

executed as outdoor work, where oil dominates altogether or over everything, as is the case with surface more absorbent than wood.

COVERING CAPACITY

Definition—Determination of the Covering Capacity of White Lead and White Zinc

No property of white lead has been so much discussed as this one. It was the subject of more controversy than its permanence, which, however, is the primordial property; but it is necessary to say that there is often confusion as to the exact meaning which should be given to *covering* or *to cover*, and it is by the definition of the exact meaning that must be given to this word that we must necessarily begin. Most theoretical, non-practical men, regard this word cover as designating the extent of surface which a given amount of paint can *cover*, whilst, in practical language, this word designates the opacity of the paint. Thus we say of a paint, it covers well when used as a comparatively *thin*, very fluid liquid paint, it, by its opacity, masks and causes the general tint of the under surface, marbling, spots, and other defects of the same nature to disappear. *The paint which masks the under surface best with the least thickness of paint, is the one which has the greatest covering power.*

This point well defined, it must be further observed, that there is occasion to distinguish between the covering power of a given pigment as a material by itself [dry colour], and the covering power of the paint which is made from that pigment, because the addition of

liquid to the pigment, to make the paint, may modify, even to a great extent, the degree of its natural opacity, as is shown in the grand and conscientious examination which we are about to read; of all examinations which have been made of this subject, it is the most reliable, the most complete, and the most decisive. It is both scientific and practical. Its deductions and conclusions are absolutely indisputable, because the scientific demonstrations agree with practical experience, which they confirm at all points:

Examination of the Comparative Value of the Covering Powers of White Zinc and White Lead, by M. Lenoble of Lille

"In this research it is proposed to determine the comparative values of white lead and white zinc. Up to the present time, numerous researches have appeared on this question, but the results obtained do not at all agree. Whilst one author deduces from his experiments, that the covering power of a paint with a white zinc base is THE SAME as that of a white lead paint, another author, again, also concludes that the covering power of white zinc is DOUBLE that of white lead. On the other hand, every painter, without a single exception, asserts that the covering power of white zinc IS LESS than that of white lead. Where is the truth? Theoretical researches all seem to attribute to white zinc a superior covering power to that of white lead, whilst practice in this respect never fails to give the preference to white lead. It may be asserted, that

both theoretical and practical men are equally right. The opposite conclusions at which they arrive are due to the fact that the observations are not made under the same conditions. It is hoped that it has been shown in this research that, in practice, white zinc covers less than white lead, and that it will always require a greater number of coats of white zinc than of white lead to cover a given surface; if it be desired, let it be well understood, to produce paintwork of good quality, solid, and durable. There is one point which, above all, should be perfectly elucidated—that is to say, the meaning which is to be given to the words *covering capacity*. Some authors have thought it well to designate in that way the greater or less extent of surface which can be covered with a given amount of paint. The author of this research does not believe that this interpretation should be accepted, and that it is necessary to designate, by these words, *covering power*, the greater or less facility with which a certain paint can hide, can cause to disappear, can, in one word, cover the (generally darker) under coats of paint. This covering power is, generally, in direct ratio with the opacity of the paint. The surface which may be covered with a given coat in no way depends on the hiding or covering capacity of the dry powder which enters into its composition, but rather on the absorbing force of this powder for liquids, and above all the amount of liquid used; the greater the amount of liquid used, the greater is the surface covered. However, there is a sane medium within which to work; because, if liquid paints be thinned to infinity, we would end by having nothing

but pure oil, which would cover enormously in extent, but would no longer have any, or, if at all, scarcely any, hiding capacity. Every liquid paint should therefore have a good body, as consistent as possible, without on that account ceasing to be fluid, flowing, unctuous, and mellow to the brush. It should not be viscous, tenacious (stiff), tacky, or hard, under the brush; besides, it should possess as intense a masking or covering power as possible. The first meaning given to the words covering power being eliminated, only one remains; covering power, in the ordinary sense, as understood by practical men. This being well defined, let us proceed to the examination itself. There were used for the purpose of these experiments:

1. Stiff white lead paint, ground in oil, Th. Lefebvre, of the following composition:

TABLE XIV.—*Analysis of Th. Lefebvre's Stiff White Lead Paint in Oil.*

	Per cent.
Ground dry white lead	87·4
Oil	11·5
Water[1]	1·1
	100·0

[1] TRANSLATOR'S NOTE.—The white lead aqueous pulp from the mills is ground in oil. The oil expels the water. The 1·1 per cent. is evidently a residuum of this water.

2. Stiff white zinc paint of the Vieille Montagne, the composition of which was:

TABLE XV.—*Showing the Composition of the Vieille Montagne Co.'s Stiff White Zinc Paint Ground in Oil.*

	Per cent.
Dry powdered zinc oxide . . .	85·0
Oil	15·0
	100·0

The density of the dry powdered pigments were—white lead 6·75, white zinc 5·60, the ratio of the densities being $\frac{6{\cdot}75}{5{\cdot}60} = 1{\cdot}205$. The stiff paints were ground in commercial linseed oil of density 0·926,[1] and spirits of turpentine of density 0·865. To determine the covering power the paint was applied in calculated proportions on square pieces of wood 2½ cms. thick (inch board) and 225 cms. (9 inches) square. On these slabs there were previously traced two bands forming a cross and each 2½ cms. [1 inch] in width. These bands were of a dark green colour, that tint being, as painters say, the shade most difficult to mask. In the first series of experiments liquid paints of the following composition were prepared:

[1] TRANSLATOR'S NOTE.—This is far too low a gravity for linseed oil at $\frac{15^\circ C}{15^\circ C}$; it points to poppy-seed oil frequently used in France, especially in white lead grinding.

TABLE XVI.—*Showing the White Lead Liquid Paints used by M. Lenoble in his Experiments.*

(Formula similar to Livache's purely theoretical.)

Composition of Paint.	Per cent.	Integral Composition.	Per cent.
Ground white lead in oil .	83·0	Dry white lead . .	72·5
Oil [additional] . .	6·0	Oil [grinding], 9·5 } Oil added, 6·0 } .	15·5
Turps	11·0	Turps	11·0
		Water	1·0
	100·0		100·0

Proportions.		Total.	
White lead . . .	100·0	Solid	100·0
Oil	21·4	Liquid. . . .	38·0
Turps	15·2		
Water	1·4		

TABLE XVII.—*Showing the Composition of the White Zinc Liquid Paint used by M. Lenoble in his Experiments.*

(Formula similar to that of the French War Office.)

Composition of the Paint.	Per cent.	Integral Composition.	Per cent.
Stiff white zinc paint in oil	76·0	Dry zinc oxide . .	64·6
Oil [additional] . .	12·5	Oil, grinding, 11·4 } Oil, additional, 12·5 } .	23·9
Turps	11·25	Turps	11·25
Drier	0·25	Drier	0·25
	100·00		100·00

Proportions.		Total.	
Dry zinc oxide . .	100·0	Solid . . .	100·0
Oil	37·0	Liquid . . .	54·8
Turps	17·4		
Drier	0·4		

With these liquid paints there were applied, on slabs, in a first experiment :

(1) Equal weights of powder (dry pigment), white lead, and white zinc.

(2) Equal volumes of these two powders.

There were three series of experiments ; all the experiments were made in two different proportions, and each double operation was repeated three times. Three coats were applied on the slab, of an identical liquid paint ; that is to say, invariably in the proportions of the first and last coat.

REMARK.—It was constantly observed that the white lead paint dried more rapidly than the white zinc paint, even though the latter always contained drier, whilst the white lead never contained any such thing.

COVERING POWER

To judge and assess the value of the covering power four operators, each separately, were charged to determine the extent to which the green cross had disappeared, and to classify the slabs according to the attenuation of that cross ; very generally the classifications were practically identical. If there were any divergences, the four operators came together to examine the non-concordant observations and solve the difficulties. Finally, a definite classification was adopted. For the three series of these preliminary essays, the following are the conclusions which followed the determinations.

1. With equal *weights* of dry pigment, white zinc covers better than white lead.

2. With equal volumes of dry pigment, white zinc still covers a little better than white lead, but the difference is very small.

3. Working with the same liquid paints, of different thicknesses, three coats, in two categories, thin coats and thick coats, it was found that: (1) In thin coats white lead covers more than white zinc. (2) In thick coats white zinc covers a little more than white lead. In the mixtures used hitherto it will be observed, that white lead and white zinc were rubbed up in unequal amounts of linseed oil and turps ; as these different conditions may perhaps modify the covering power of the dry pigment, it was decided to use in the definite experiments only exactly similar mixtures containing identical proportions of solids and liquids. But what were the proportions of oil and turps with which the dry pigments should be rubbed up? The point was solved thus:

1. Mixtures, similar to those which the painter is in the habit of using for white lead and white zinc were prepared by a painter, and the author of the research determined, himself, the proportions of paste, oil, and turps used in each case.

2. Books were consulted for the proportions which different authors recommend to be used in the preparation of white lead and white zinc. In possession of these data, it was resolved to carry out the experiments in three different degrees of concentration: the most highly concentrated mixture is favourable to white lead; the most fluid responds to the composition of mixtures used for white zinc; the third is intermediate, between the two others. Two classes of white lead and white zinc paints

were prepared—(1) equal weights, (2) equal volumes, and three values as regards fluidity or liquid content.

TABLE XVIII.—*Showing the Composition of White Lead Paints of Different Fluidities used by Lenoble in his Experiments.*

	1st Coat.	2nd Coat.	3rd Coat.
	lbs.	lbs.	lbs.
Stiff white lead in oil .	100	100	100
Oil [additional] . .	16 } 20	20 } 24	24 } 30
Turps	4	5	6

Hence the three degrees of fluidity are 20, 25, and 30.[1]

TABLE XIX.—*Showing Composition of White Zinc Liquid Paints used by Lenoble.*

Number of Coat.	Equal Weights. I.	II.	III.
Stiff white zinc paint in oil	100·0	100·0	100·0
Linseed oil, additional .	10·8 } 14·6	14·6 } 19·4	18·4 } 24·1
Turps	3·8	4·8	5·7
Number of Coat.	**Equal Volumes. I.**	**II.**	**III.**
Stiff white zinc paint in oil	100·0	100·0	100·0
Linseed oil, additional .	16·0 } 20·6	20·6 } 26·3	25·2 } 32·1
Turps	4·6	5·7	6·9

[1] TRANSLATOR'S NOTE.—Not at all to each of these fluidities must be added the 11·5 per cent. of oil and 1·1 of water in the stiff paint for 87·4 of dry white lead, which, calculated to 100 parts of dry white lead = 14·4 per cent., so that the fluidity is 34·4, 39·4, and 44·4.

In the same way, the fluidities for each coat of white zinc differ. All these paints were applied on slabs bearing a green cross. Each slab got three coats of their respective paint (white lead or zinc), and always with the same liquid paint as served for the first coat. After each coat, and immediately after drying, the covering capacity was estimated and the slabs classed. The results were the same for one, two, and three coats, and in the final classification it was found in all cases that white zinc covered more than white lead, but when the coats are coats of equal volumes the differences were slightly less. To determine the value of the ratio of the covering capacities of white lead and white zinc, all the slabs painted with white zinc were classified in the order of the disappearance of the green cross, and a regularly decreasing scale of intensity was thus obtained ; then three observers, working separately, tried, in this scale of slabs, to find the one in which the disappearance of the green cross was perceptibly equal to the disappearance of the cross, for each one of the slabs painted with white lead. After the final classification, a table was prepared giving the quantities of dry pigment deposited on each slab; then, by means of the results of this table, the ratio of the weight of white lead and white zinc which cover the same surface equally was determined. Classifying these results, according to a known method, in order of magnitude, then striking an average, the differences which exist between the average and each of the values obtained were determined. The averages obtained show that the ratio of the covering powers is approximately equal to 1·4, which means that the weights of white lead and of

white zinc laid on equal surfaces, and beaten up in equal quantities of oil and turps, should be to each other in the ratio of 7 to 5, so that the covering power be the same. Now, the densities of these two substances being to each other as 6 is to 5, it follows that, taken at equal volumes, the covering power of these two dry pigments are to each other $\frac{7 \times 5}{5 \times 6} = \frac{7}{6}$. Therefore, with equal volumes, white zinc still covers more than white lead; but the difference is smaller than with equal weights. These results, obtained by calculation, are in absolute agreement with the conclusions drawn from the experiments. Throughout the whole of the preceding, the durability of the paints was not taken into account; the coats were often very thick, calculated for our purpose, the value of the covering power of the dry pigments. They were not mixed in the conditions required by practice, in which it is necessary, for the paint to be durable, that the coats should be applied thin. Moreover, white zinc requiring a greater quantity of liquid than that required by white lead, the amount of liquid should certainly be greater than that used here, and these are some indications on this point drawn from the experiments.

For white lead, the master painter already referred to, used 47·2 parts of liquid for 100 of dry pigment, and the author of these experiments found that his liquid paint was too fluid. Another practical liquid paint, brought forward by Livache, was 37·6 parts of liquid for 100 of dry pigment. The compositions used in these experiments contained 38 parts of liquid for 100 of dry pigment, and in our later trials they descended to 34·8

of liquid for 100 of dry pigment. It may be asserted, as a result of these observations, that to obtain an excellent white lead liquid paint, the substances should be mixed in the proportion of 35 to 38 parts of liquid for 100 parts of dry pigment.

For white zinc, the master painter already quoted, uses 58·9 parts of liquid for 100 parts of dry pigment; the French War Office, 56 parts of liquid for indoor work, and 68·6 parts for outdoor work. The practical man, indicated by Livache, uses 44·1 parts of liquid for 100 parts of dry pigment. Another practical man, a Belgian, does not use less than 73·65 parts of liquid, and his proportions sometimes rise to 86·6, even as high as 98·8, for a first coat, it is true. Thus the above composition, which contained 54·2 parts of liquid, should be regarded as insufficient, and it must be acknowledged that a good white zinc paint should contain 60 parts of liquid for 100 parts of dry pigment. It may be observed that this proportion is a minimum, always exceeded, in practice. This being so, it is possible to calculate the number of coats of white zinc which it is required to apply on a given surface, to obtain the same result as regards covering power, as with a given number of coats of white lead liquid paint.

Take it, that the following liquid paints are used:

TABLE XX.—*Showing Composition of White Lead Liquid Paint used in Trials against Zinc Oxide.*

	Lbs.	
Dry white lead	100	
Oil	24	36
Turps	12	

136 grms. of this paint occupy a volume of 54·60 c.c. [54·6 fluid oz. weigh 136 oz. avoirdupois]. 100 grms. of this liquid paint contain 73·53 grms., or 10·9 c.c. of white lead [100 oz. avoirdupois contain 73·53 oz. avoirdupois of white lead, or 10·9 fluid oz.]. 108 c.c. of this liquid paint contain 183·15 grms. or 27·13 c.c. of white lead [183·15 oz. avoirdupois occupy the bulk of 108 fluid oz., and contain 27·13 fluid oz. of dry white lead].

TABLE XXI.—*Showing Composition of White Zinc Liquid Paint by Lenoble in his Trials against White Lead.*

White zinc ground in oil, 33·4 per cent.	820
Oil	60
Turps	90
Drier	30
	1000

Proportion of Dry Pigment and Liquid.

Dry pigment	100	lbs.
Oil	61·2	,,
Turps	15·5	,,

177·7 grms. of this liquid paint occupy a volume equal to 103 c.c. (say 103 fluid oz. weigh 177·7 oz. avoirdupois). 100 grms. of this liquid paint contain 56·27 grms., or 10·05 c.c. of white zinc (say 100 oz. avoirdupois contain 56·27 oz. avoirdupois, or 10·05 fluid oz.). 100 c.c. of this liquid paint contain 97·09 grms., or 17·34 c.c. of white zinc (say 100 fluid oz. contain 97·09 oz. avoirdupois, or 17·34 fluid oz. of white zinc). Take it, once more, that coats of paint of equal thickness are deposited on equal areas, this hypothesis is favourable to white zinc, and as a consequence of this hypothesis we regard the coats as being composed of equal volumes. Suppose now, that

for the application of paint to a given surface, it is necessary to use 100 c.c. of white lead for one coat. Three coats would require 300 c.c., $183{\cdot}15 \times 3 = 549{\cdot}45$ grms. of white lead. To cover equally the same surface with the white zinc paint would require a quantity of white zinc equal to $\frac{549{\cdot}45 \times 5}{7} = 392{\cdot}46$ grms., since the covering power of the two are as 7 to 5. Now this amount of powder is contained in $100 \times \frac{392{\cdot}46}{97{\cdot}07} = 404{\cdot}2$ c.c. of liquid white zinc paint, that is to say, the value of four coats. We arrive, therefore, at this very interesting conclusion, absolutely conformable to the ideas of practical men. That it requires four coats of white zinc paint to cover as much as three coats of white lead paint.

The conclusions arrived at in this research differ from the results obtained by the greater number of authors who have examined the question of the covering power of white zinc. The divergences which may exist can be realised by the remark, that an experiment is of no value except in the precise conditions under which it has been performed. Change these conditions, and the result is immediately modified. In all these experiments it has been tried to approach, as far as possible, the conditions of actual painting ; that is why the results have the advantage of being in absolute agreement with those obtained by all practical men."

Lenoble's research has a double merit: first, that of being executed under normal conditions of working; and being, thus, quite another thing from an aggregate

of laboratory experiments, which most often are opposed to the results obtained in practice. Its second merit is in it being possible to demonstrate, by calculation, that if white zinc has more covering power, as material pure and simple, it loses this advantage when made into paint, and that in virtue of the larger amount of liquid which it absorbs and its use necessitates. Q. E. D.

CHAPTER VII

THE EXPERIMENTS OF THE DUTCH COMMISSION OFFICIALLY ENTRUSTED TO MAKE COMPARATIVE TRIALS BETWEEN WHITE LEAD AND WHITE ZINC

PAINTERS cannot be too strongly recommended to read the whole of the chief sections of the report now placed before them. There will be found in the programme of these experiments, amongst other things, the official acknowledgment of certain fundamental principles in painting with white zinc, an admirable method of precise working, the indication of certain very interesting eventualities. The reading of this report is most instructive, owing to the judicious remarks which are to be met therein at each step. Certain very suggestive technical assertions or denials, the presentation of the numerous formulæ, is also very interesting, as much in regard to the quantity as to their composition, which is quite peculiar, and so little in harmony with French practice. The Dutch formulæ are, in fact, very complicated, compared with the French; and especially, the simultaneous presence in a liquid paint of three or four oil-drying principles, of the same nature, is rather

calculated to surprise us (French painters). But on reflection, and when one takes into account the difference in the respective climates, it clearly appears that the Dutch make, theoretically, better paint than the French, who may perhaps make it prettier, but probably also less durable and less efficient, as a protective coat, than the Dutch. But practically, and according to the results even of these experiments, which are to be found in the final report following the provisional report, it would not appear that the composition of Dutch liquid paints produces paintwork of very superior durability.

Provisional Report (October 6, 1906)

The Commission took the following facts for granted at the outset :

1. That for indoor work white zinc is, already, generally used, although it be, in addition to one or several coats, of white lead.

2. That for outdoor work, white zinc sometimes replaces white lead in particular cases.

3. That it is admitted almost everywhere that white lead covers better than white zinc, and that to obtain the same covering with white zinc it is necessary to apply, on the surface to be painted, a greater number of coats than with white lead. The Commission therefore was of opinion that it was necessary first of all to find out—

(*a*) Whether the first coats of white lead mentioned in paragraph 1 above, can be replaced by coats of white zinc, and if the white lead *enduit*, putty, etc., can be replaced by an *enduit* free from lead.

(*b*) Whether white zinc, or any other paint, ca white lead for outdoor work in all cases.

(*c*) Whether it is possible to prepare white with as great a covering capacity as that of w so that the former requires no more coats than th

As regards (*a*), this fact may be regarded, strated by experience, that whilst a first coat lead on a new surface adheres to it intimately white zinc exhibits under similar circumstance herence, and very often scales and comes off in

If some try to find the cause in the nature o stance of the object to be painted, most trades r the greater hardness and the less suppleness of white zinc paint compared with a coat of paint. Experienced painters have tried to substances to white zinc, and with success—och white, for example—to render the coat less hard supple. The Commission resolved, for white paints, to use similar methods; then, after some preliminary experiments, it decided to use in work, as *enduits* free from lead, an *enduit* of the composition:

TABLE XXII.—*Showing the Composition of the Commission's Substitute for a White Lead "Endui*

Boiled linseed oil	
Raw linseed oil	
White zinc	
Turps	
China clay	
Paris white	
Drier	

As regards (*b*) and (*c*), the Commission thinks that the good quality of the white lead used in Holland prevented them from instituting searching experiments with other paints, since only searching experiments can teach in what relative proportions different solids and liquids should be mixed to produce the best paints. And therefore, in its opinion, the question finally resolves itself into trying to find whether, by more skilful adjustment of the proportions of the different constituents, and by better manipulation, a white zinc paint, or another paint, might be produced, the quality of which would approach that of white lead, for outdoor work, more than has been done hitherto. As regards the experiments to be undertaken by the Commission, it was soon specified that these would be, to as little extent as possible, experiments on a small scale, laboratory experiments, but rather experiments on a wide basis, and executed under such conditions that, bearing on actual practice, their greater or less practical value would be apparent and show itself forthwith. The Commission asked itself, moreover, if it would not be more desirable, even although looking at the terms of its reference—only to consider white lead paint—to try to find, if another lead paint very much used, red lead, could not be replaced entirely, and successfully by a less dangerous colour, namely, red oxide of iron—of very frequent use—although, in fact, the properties of red lead are not of such a nature as to render this pigment as poisonous as white lead [*sic*]. As the experiments required for this purpose could very well be carried out alongside with the other experiments which the Commission had to conduct, and with very little extra

expense, it decided on the second series of experiments. The Commission decided to make comparative experiments with white lead, white zinc, and other pigments.

1. *On new wood, and on wood already painted, on plaster work, on zinc.*—These materials to be exposed to the outdoor air, and to all kinds of weather, and other influences, prevalent in Holland.

2. *On iron exposed to the outdoor air*, as is the case in the metalwork of large bridges.

3. *On wood exposed to the moisture of the air and the vapours of the sea.*

4. *On iron exposed to the air and to sea water.*

5. *On wood for indoor carpentry.*—The Commission afterwards enumerates the sites which were granted them on which to conduct the experiments. They are briefly given here, with the sole object of showing that the experiments were conducted on really practical surfaces, and in every way conforming with the usual working conditions.

As regards 1.—The façades of four large indoor courts of the Palace of Justice, Amsterdam.

As regards 2.—The largest arch, on *terra firma*, of the railway bridge, near the lock of the West Docks at Amsterdam.

As regards 3.—The wooden gables of two houses of Government officials, situated on the point farthest out in the sea.

As regards 4.—A State guardship, the *Argus*, engaged in the policing of the North Sea.

As regards 5.—Ten new doors, intended for the buildings of the higher Technical School of Delft. Before com-

mencing the experiments the Commission also came to the following decisions, namely:

1. As regards white lead painting, as many experiments would be made with old Dutch white lead as with German lead.

2. As regards painting with white zinc, as many experiments would be made with Maestricht white zinc (plumbous oxide), as with that free from lead (Vieille Montagne and Silesian).

3. That experiments would be made with lithopone.

4. That experiments be also made with a white zinc paint, specially prepared by Overman, in such a way, he asserts, as to render it more resistant to outdoor air, according to a method of mixing which he imparted confidentially to the President of the Commission.

5. That pure homogeneous raw linseed oil be used.

6. That linseed oil, which should be boiled, be so boiled by the Commission itself, without admixture with substances containing lead.

7. That all the pigments and the oil, before being prepared, be subjected to analysis, under the supervision of the Commission, to ensure their good quality.

8. That all the pigments be manufactured under the continual supervision of at least two persons of trust, one at least being a member of the Commission.

9. That all the pigments be ground and manufactured by means of the special grinding rolls in use in the locality, then dispatched in soldered tins to the different places of use.

10. That the paints, during the experiments, be under

the charge of an approved craftsman, who will also permanently supervise the application of the paints.

11. That as many experiments be made with perfectly white paint as with slightly tinted paints.

12. That care be taken, above all, in the experiments with white lead and white zinc, that the coats be always applied as far as possible under identical conditions, and on surfaces which are and remain under quite analogous surrounding conditions.

13. That the coats of red lead and red oxide of iron be applied on pieces of iron, previously well stripped and cleansed.

14. That, along with experiments on paints conducted according to the style of composition prescribed by the Commission, comparative experiments be also made with paints of the same composition as those on which the similar French Commission, which in its researches has taken, so to speak, a leading place.

The Commission afterwards decided, after a long discussion, the composition of the different coats, as the tables show in detail, and the manner in which they should be applied on the buildings, the bridge, the vessel, and the carpentry work, all, moreover, conformable with the practice usual in Holland. Then the tests decided upon were executed under minute and permanent supervision, according to the above-mentioned resolutions of the Commission. Moreover, its members themselves took care, at different times, to control and follow these experiments, and to register all the details, on completion. Then, as in Holland, outdoor paintwork, supposing it properly done, is in general renewed every four or five

years, the Commission held that it should evidently follow the experiments undertaken, for as long a period of time, so as to be able to pronounce definitely on the financial results of the eventual replacement of white lead; and resolved, subject to this consideration, but always in a provisional manner, to note exactly the condition of the experimental paintwork as a whole, to assess its quality, and to compare them between each other every spring and autumn. In carrying out these valuations, in the course of which the painted surfaces were carefully examined, the Commission resorted, amongst other methods, to a brush test, which consisted of this: a portion of the surface—to be examined as regards the application of the paints—is cleansed very minutely with a soft sponge and clean water, from the dirt fixed on it; then there is given, on this perfectly clean spot, a score of blows with a rather wide and hard, well-moistened brush, which afterwards is shaken above clear water. If the paint does not become detached in any way, because it is sufficiently adhesive, no coloration of the clear water will be produced. But if the paint becomes detached more or less, there is to be observed more or less numerous dark specks of paint which appear in the water. It is to be noted that several months after starting the experiments on the bridge of the lock of the docks, it was found that certain of the results brought out differed from the data collected elsewhere in other experiments. That was the subject of a long discussion between the members of the Commission, who finally decided to set to work to find out the cause of these differences, by means of more experiments and more exhaustive, critical

examinations. It was then resolved to erect a cross piece, with forty iron plates, placed and painted, under conditions indicated in Appendix II, then to observe them with the same care.

In the meantime, the Commission had succeeded in elaborating a certain method of mixing white zinc paints, which seemed at first sight to be in no way inferior to white lead paint. It was therefore decided, so as to elucidate this point well, to submit the covering power of the two paints to more careful comparative examination, which was done under the conditions detailed in Appendix III. Then the Commission, once the slabs painted as described were quite dry, examined them carefully in broad daylight, and came to this unanimous conclusion—that, in the use of the white lead paints and the white zinc paints, on which the experiments of the Commission have been brought to bear, and which moreover appeared of very practical use, it was found that white zinc is in no way excelled in any respect by white lead as regards covering power ; it may even be regarded as having a slightly greater covering power. The report ends by details of researches of a different nature, undertaken by the Commission, especially as regards the different oils, experiments on raw oil slightly coloured, as well as grinding appliances.

Then it gives the formulæ for the proportions used in the comparative paint experiments. The interesting formulæ, as regards white zinc, are all reproduced here. It is advisable to point out that the formulæ are for four coats, in the same way as for white lead, which clearly shows that the practice in Holland is more careful than in France, where the fourth coat is regarded as quite excep-

tional; and it is a little surprising that paintwork in Holland is renewed every five years, as the Commission observes; in France, three coats even of white zinc are given, which stand that length of time.

TABLE XXIII.—*Showing Proportions by weight for Paints fixed by the Dutch Commission for Comparative Trials, in their trial tests with Plumbiferous White Zinc and without Addition of Lead for Outside Work on New Wood or on Unpainted Plaster or Cement Work.*

Number of Coat . . .	I.	II.	III.	IV.
	lbs.	lbs.	lbs.	lbs.
White zinc	40	80	80	80
Yellow ochre	40	...	...	...
Boiled oil.	100	$2\frac{1}{2}$	$2\frac{1}{2}$	7
Raw oil	40	30	30	27
Turps	...	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$
Drying oil	...	...	...	$7\frac{1}{2}$
Drier	5	1	1	$\frac{1}{2}$

These formulæ do not appear to be very rational. In any case, looked at from French practice several anomalies are to be seen. At the outset, these formulæ are given for wood, plaster, and cement. In France, these different substances would not be treated alike. In the priming coat for wood, a little turps would be added to facilitate absorption and help in the subsequent rubbing down; on

plaster, it would be dispensed with entirely, at least in priming. For wood again, at least for outdoor work, as is the case here, there would be no turps in the last coat, which would be the third or the fourth. Neither can the simultaneous presence in a liquid paint of a drying oil, boiled oil, and a drier be very well explained, these three products having almost identical oxidising properties.

TABLE XXIV.—*Showing Proportions by weight for Paints fixed by the Dutch Commission for Comparative Trials, in their trial tests with Plumbiferous White Zinc and without Addition of Lead for Outside Work on Wood already painted* (*Outdoor*).

Number of Coat	I.	II.	III.	IV.
	lbs.	lbs.	lbs.	lbs.
White zinc	40	80	80	80
Paris white	40	...	...	...
Boiled oil	100	2½	2½	7
Raw oil	40	30	30	27
Turps	...	2½	2½	2½
Drying oil	...	...	...	7½
Drier	5	1	1	½

These formulæ are absolutely identical with the preceding. There is no difference, except in the replacement of yellow ochre by Paris white (chalk) in the priming coat,

and the author sees the utility of neither, even if added to impart less hardness to the coat, as the Commission declares in its preliminary remarks.

TABLE XXV.—*Showing Composition of Experimental Paints used by the Dutch Commission on Plaster on Outdoor Work.*

Number of Coat	I.	II.	III.	IV.
	lbs.	lbs.	lbs.	lbs.
White zinc	80	80	80	80
Boiled oil	100	2½	2½	7
Raw oil	40	30	30	27
Turps	...	2½	1½	2½
Drying oil	...	...	...	7½
Drier	5	1	1	½

Formulæ, still identical with the two preceding coats, excepting the addition of ochre or chalk. This similarity shows that no distinction whatever was made between the nature of the object to be painted—wood, plaster, or cement; and it is very surprising such uniformity of composition, being quite contrary to the most elementary practice, by which each kind of material should be treated specially, especially in first coats, the fluidity and proportions of oil and turps should harmonise with the degree of absorption of the object, the other coats being treated according to the exposure of the paintwork, whether indoor or outdoor.

TABLE XXVI.—*Showing the Composition of the White Zinc Paints used on Zinc by the Dutch Commission.*

Number of Coat	I.	II.	III.	IV.
	lbs.	lbs.	lbs.	lbs.
White zinc	40	80	80	80
Yellow ochre	40	...	...	...
Boiled oil	100	2½	2½	10
Raw oil	40	30	30	27
Turps	...	2½	2½	1½
Drier	5	1	1	½
Drying oil	...	...	...	3¼
Flatting varnish	...	...	...	3¼

TABLE XXVII.—*Showing the Composition of the White Zinc Paints used by the Dutch Commission in their Trials with Plumbiferous White Zinc (Maestricht Zinc), but without Added Lead for Indoor Work on New Wood.*

Number of Coat	I.[1]	II.	III.	IV.
	lbs.	lbs.	lbs.	lbs.
White zinc	40	80	80	80
Yellow ochre	40	...	...	...
Boiled oil	100	...	...	...
Raw oil	40	22½	22½	22½
Drying oil	...	...	...	15
Turps	...	12½	14	2½
Drier	5	0·5	0·5	0·5
Porcelaine varnish	...	...	...	30

The use of boiled oil in a priming coat is somewhat abnormal.

[1] Priming coat.

TABLE XXVIII.—*Showing the Composition of the Experimental Paints used by the Dutch Commission in their Trials with Lithopone for Outdoor Work on New Wood or on Unpainted Plaster or Cement Work.*

Number of Coat	I.[1]	II. and III.	IV.
	lbs.	lbs.	lbs.
Lithopone	50	87	87
Raw oil	50	27	12
Boiled oil	50	...	10
Drier	1	1	0·5
Turps	...	2½	1·7
Drying oil	...	...	7·5

TABLE XXIX.—*Showing the Composition of the White Zinc Paints used by the Dutch Commission in their Trials with Lithopone on Indoor Work on New Wood.*

Number of Coat	I.	II.	III.	IV.
	lbs.	lbs.	lbs.	lbs.
Lithopone	50	87	87	87
Raw oil	100	22½	22½	22½
Drier	3	½	½	½
Turps	...	10	12	2½
Drying oil	...	...	...	15
Porcelaine varnish	...	...	...	30

Trials with Red Lead and Red Oxide of Iron. Paintwork done on the Vessel Argus.—For this trial job two priming coats were given with the different miniums. [In France

[1] Priming coat.

red lead is minium of lead and red oxide is minium of iron. Lavoisier could not understand what Priestley meant by *Plomb Rouge*, one of the sources from which he tried to tell Lavoisier he could produce oxygen.] These priming coats were covered by paints with a white lead basis and a white zinc basis alternately, and in succession white lead and zinc on red lead then on red oxide.

TABLE XXX. — *Showing Trial Proportions for Priming Coats used by the Dutch Commission on New Iron or Iron made New. First and Second Coats.*

Number of Coat . . .	I.	II.
	lbs.	lbs.
Red oxide . . .	80	...
Red lead	...	80
Raw oil.	20	8
Boiled oil	20	8
Turps	$7\frac{1}{2}$	2
Drier	5	...

The author cannot at all explain the absence of drier in the last formula (red lead). It is not a printer's error, as it is absent in all the repetitions of this formula in the different tables of the two reports.

TABLE XXXI.—*Showing Composition of Coats of White Zinc Liquid Paints Applied on "Minium" Primings as used by the Dutch Commission in their Experiments with Red Lead and Red Oxide of Iron.*

Number of Coat . . .	I.	II.
	lbs.	lbs.
White zinc	80	80
Raw oil	30	27
Boiled oil	2½	7
Drying oil	...	7½
Turps	2½	2½
Drier	1	½

Trials of Paints on Iron Plates.—These plates, about one metre square (40 inches square), numbered 44. They each received on half their surface two priming coats, with red lead and red oxide. These foundation coats were of the same composition as those which were given for the *Argus*. The finishing coat, above the minium (red oxide red lead), was given with all the products examined, white lead, white zinc, lithopone, with coats of the same composition as those which had served on the Amsterdam Docks, and the results of which were in contradiction to other and similar experiments. Then, various compositions were applied, such as the composition, termed "flatting white zinc."

TABLE XXXII.—*Showing Composition of Flatting W Zinc Paint and First Coat for Same.*

Number of Coat . . .	I.	II.
	lbs.	lbs.
White zinc	80	80
Raw oil	30	27
Boiled oil	2½	10
Drying oil	...	3¾
Turps	2½	1½
Flatting varnish . . .	...	3¾
Drier	1	½

COMPARATIVE TRIALS OF THE COVERING POWE OF WHITE LEAD AND WHITE ZINC

It has been seen, in the part of this report where Dutch Commission explained the programme of its periments, that there is a question of experim undertaken to establish the exact degree of cove capacity of white zinc by means of liquid paints special composition, and, by comparison with white prepared normally. It has also been seen, that the re of these experiments was conclusive in favour of white z which was recognised as covering as much as, if not n than, white lead. It will be interesting to know v method the Commission adopted to form its judgm The following was the method of working adopted : boards 1 metre in length and breadth, thus havir surface of a square metre (say 40 inches square), v coated on one side only with white lead those marke

The other five were likewise painted on one side, but with white zinc. They had all previously received a priming coat, had been filled up, and rubbed down, with the same white paint. Finally, squares were painted on the surfaces so prepared, after the style of a draught-board, in such a way that each board showed eighteen white squares and eighteen black squares of equal size. On other boards, the black squares were replaced by squares painted dark green. Finally, these plates were painted all over with a coat of white paint, and, as pointed out already, either with white lead or white zinc, all of which amounts to this, that the boards first got two uniform foundation coats, that on this foundation a draught-board with black squares was painted, and on the other boards a draught-board with green squares was painted, and that on these draught-boards a coat of pure white paint was applied, white lead on the one hand, white zinc on the other.

The covering coat, that which masked the draught-board, was coated, as regards white zinc, with a liquid paint of a special composition, prepared so as to impart to the white zinc a greater covering power, or opacity, than is normal to it. This liquid paint was the fourth coat in the liquid paints, for painting on new wood for outdoor work (Table XXIII.).

	lbs.
White zinc	80
Raw oil	27
Boiled oil	7
Drying oil	7½
Turps	2½
Drier	½

On examining these different specimens, of which such a great number was not, surely, necessary, the Commission found, in a very mechanical fashion, differences in the covering power between the boards. The advantage in every case was in favour of white zinc, except in one instance; sometimes it amounted to 5 per cent. on the white lead, sometimes to 3 per cent. It would have been just to have likewise given the proportions for the white lead liquid paint, and still more just to have applied two covering coats, one coat alone not affording sufficient testimony to decide so grave a question. See on this point the remarks of the Author on Chapter VI. Finally the report concludes, that white lead is deficient in covering power, in the ratio of 4 per cent. compared with white zinc paint. That is very decided! But the Commission does not say by what process of visual calculation it was able to assess, so mathematically, the percentage of differences, and that is what it would be necessary to know.

At the time that the manuscript of this treatise went to press, the Author had no knowledge of the results of the numerous and very interesting experiments undertaken, with so much conscientiousness, by the Dutch Commission. The most important point was then unknown to him, and his inability to inform the reader was the cause of profound regret. But, on making direct application to the Minister of the Interior at the Hague, for definite information as to this report, it was very courteously forwarded by His Excellency, and the general secretary was good enough to say that his department was greatly interested in this treatise, and to be good

enough to inform him of the date of its publication, which was done with great pleasure.

The following is the résumé of the report, and its definite conclusions on these experiments, the best conducted of any on this eternal question of the competition between the two whites. Looking to their great importance, the results are given in a separate chapter.

CHAPTER VIII

RESULTS AND CRITICISMS OF THE EXPERIMENTS OF THE DUTCH COMMISSION. FINAL REPORT OF OCTOBER 5, 1909

LITERAL TRANSLATION OF THE ESSENTIAL PARTS

. . . .

11. FOR the examination of the paintwork, the Commission made a test with a scrubbing-brush, cleaning a part of the painted surface with a soft sponge, moistened in clean water, to remove previously all dust and other filth. The surface so cleansed was then scrubbed several times, with a rather hard, wet, flat brush, which was then shaken afterwards above clear water; if the paint gave itself up, more or less to the scrubbing with the wet brush, that was immediately shown by more or less dark shades of colour produced in the water where the brush was shaken. The purity and the limpidity of the water showed, on the other hand, that the paint was very adherent, and had not weakened.

12. The paintwork at the Palace of Justice of Amsterdam was executed in May and June 1904. During the succeeding quarterly inspections, by the whole of the Commission, it was soon seen that the surfaces

painted with lithopone gave way, perceptibly, on the first inspection, which was determined by the brush test, whilst barely touching the paintwork. This detaching of the lithopone paint continued throughout in such a way that it was soon found *that it was absolutely impossible to replace white lead by lithopone in outdoor work.*

The white zinc M.N.N. did not behave very well on the first inspection, and from no point of view did it behave so well as the white zinc used by the Commission. The white zinc paints, made according to the data of the French Commission, did not behave so well as those made according to the proportions used in Experiments II and IIA.

Paints made with German White Lead did not behave so well as those made with Dutch White Lead. They gave way rapidly.

To resume: Dutch white lead paints, compared with white zinc paints, have suggested to the Commission the following remarks:

In the beginning, that is during the first three years, the white zinc paints gave slightly better results than those with a lead basis. They did not give way so easily under the wet-brush test. No fault could be found anywhere. It was not until the inspection of the 23rd October 1908, consequently three and a half years after their application, that crevices were produced on their surface, in some rather rare spots at first, especially on woodwork exposed to moisture, where these defects, once produced, increased at such a rate that, in a short time, the woodwork was in a deplorable condition. However, on smooth, vertical, wooden surfaces, on iron,

zinc, or cement work, these white zinc paints behaved as well as those with a lead basis, and the two kinds of paint were found, at the expiry of the determination, absolutely identical. As regards paintwork on zinc roofing, there was occasion to observe and remember, that, in certain corners, a great amount of soot was accumulated from the chimneys of a large refinery close by. This soot, owing to its sulphurous and even sulphuric acid content, *attacked paints with a zinc basis very rapidly*. In other spots the white zinc behaved quite as well as Dutch white lead.

13. If the Commission decided, very promptly, after the examinations of October 1904, that the work painted with lithopone resisted atmospheric influence and outdoor temperature badly, it determined, on the other hand, that white zinc placed in the same conditions can support, boldly, comparison with white lead paints (Experiments II and IIA). White zinc, in a general manner, and continuous fashion, gives way, less under the brush test than Dutch white lead, and *much less* than German white lead.

14. On the new doors, inside the Polytechnic School of Delft, all the paintwork gave the same results.

15. The paintwork on the metallic surfaces, undertaken on the large arch of the Railway Bridge, near the lock of the West Docks, Amsterdam, was executed in September 1904. On the general inspection in April 1905, the Commission found, immediately, that the paintwork behaved very differently here from elsewhere. *The white zinc paints gave way more than the white lead paints, and even a little more than the lithopone paints.*

In the course of a second inspection, it was clearly seen that a part of the white zinc paintwork on this bridge had given way under the rain. The Commission thought, after a careful examination, that the true cause of this fact was, that the metallic surfaces painted with white zinc had suffered much under the influence of sulphurous vapours, during the time the paint was being applied, and on which they acted, before drying. The destructive action of the sulphurous acid contained in the smoky fumes from numerous steamboats, which were stationed in the neighbourhood at that time, and also owing to the influence of the smoke from locomotives which passed over the bridge, and sometimes remained there for a considerable time. So as to decide the point, the Commission thought it was desirable to place on the bridge plates of iron, some of which were painted and dried in the workshop before being brought to the bridge and fixed on it. The other plates were brought, fixed, and painted on the spot. The Commission also resolved to place similar plates on other bridges much less exposed to smoke than the bridge of the lock of the West Docks of Amsterdam. The composition of the coats of paint on these plates is given in Appendix IV. One of these series of iron plates so applied, at once showed that it did not respond to the end in view; the plates of this series were previously cleansed from their rust by means of a strongly acid solution, but insufficiently washed, so that they all rusted beneath the new paint. They were, therefore, replaced by another series, freed from rust by other means. They were, finally, installed on February 1908.

On the subject of the result obtained with these plates, this is what the Commission declares:

1. That lithopone does not stand the open air.
2. That plates painted according to the formulæ of the French Commission gave way rapidly and lost their appearance.
3. That Dutch white lead paint and good white zinc, formulæ of Appendices II and IV, behaved equally well on the Stock Van Holland and on the Canal Bridge of Merwede. But on the bridge of the lock of the West Docks of Amsterdam, the plates painted with zinc, although proportionately of less surface than the zinc paint on the bridge itself, were in a less advantageous position than the plates painted with white lead. This enables it to be determined, taking into account also the results of the paintwork on board the boat, *Argus*, that the cause of the lesser value of the white zinc paints on the bridge of the lock of the West Docks, Amsterdam, should not be attributed to the material used, but to the effect of sulphurous gas, which has moreover been confirmed by laboratory experiments.

16. *Result of Experiments on the Police Boat*, Argus.—Immediately after the execution of the trial paints, in April 1904, the *Argus* put to sea and did duty there. On its return, the Commission examined the experiments, from which it appeared that the white zinc was in

better condition than the white lead, which gave way, more or less, under the hard, wet scrubbing-brush test rubbed on the paint, to judge of its adherence.

In April 1905, the *Argus* was again painted with the paint, mixed according to the formulæ of the Commission. After four years, it may be declared that the white zinc always behaved a little better than the white lead.

17. *Result of the Comparative Trials between Red Lead and Red Oxide of Iron.*—The composition of the coats are given in another part (Appendices II, III, IV). From the aggregate of the experiments made with this kind of paint (red lead, red oxide) on the different bridges, on iron plates, on the boat *Argus*, it follows that there were employed as a priming coat, for metallic surfaces, for one half, red lead; and for the other half, red oxide. The Commission could not determine any perceptible difference in the comparative durability of these two miniums, but it found that it was necessary to work more carefully with red oxide than when using red lead.[1]

Red lead dries very slowly. If the layers of red oxide are not perfectly dry and hard when other coats of paint are applied on them, it is to be feared that the latter will contract afterwards. The more thin the fresh coat of paint to be applied on this red oxide, the more certain will be its contraction afterwards. White zinc paint being more thin than white lead paint, the same drawback occurs quicker with white zinc in rough work

[1] TRANSLATOR'S NOTE.—The author very advisedly queries this. A mixture of equal parts of genuine red lead and genuine red oxide is a good paint. The translator has seen it used in two or three coats on certain parts of barges, with excellent results. Moreover, a good red oxide is very easily applied.

than when it is a case of white lead painting. However, when the coats of red oxide of iron are quite dry and hard, the ultimate contraction of the superimposed coat is not to be feared.

White zinc, according to the French formula, is much thinner, and is thus applied in less favourable conditions. It follows, from experiments made during a long time in the shipyards of the Navy [Dutch], in the painting of iron ships with red oxide, on the hull, that this red oxide cannot be utilised on the parts of the hull placed *under* water [below the watermark].

18. *Results of the White Zinc* "Enduit."—The white zinc *enduit*, which the Commission utilised in all necessary cases for all paints with a zinc basis, proved that it was as useful, and could be wrought as easily as the white lead *enduit*, and that it was not dearer than the latter.

CRITICISMS [BY THE AUTHOR] ON PRECEDING DECLARATIONS

[*Paragraph* 12.—It was to be foreseen, that the paint of the special composition presented by M.N.N. could only yield the usual results, and that, because this paint always had the same base, zinc oxide, to which, at the present day, no better binder can be given than linseed oil, one must not, therefore, expect much better results than those which we know how to obtain by rational methods. To constitute a new paint, or one at least having new properties, it requires: Either a new metallic base from those presently known and in current use, or it requires binders of another nature, and if not superior,

at least equal, to linseed oil, which is not yet within the domain of science. It would be necessary, also, to alter the physical and chemical constitution of a given base, which is hardly within the province of man, except with a trace of genius. With one of these three conditions, one can alone hope to do something really new, and change the properties of known elements ; but to desire to obtain superior paintwork, with the usual products, by means of more or less mysterious mixings, is absolutely Utopian. The normal durability and permanency of a paint, prepared normally, will never be increased by any such scheming, because neither the constitution nor the nature of the products used is in any way altered. It may even be said, that the difference in the durability and permanency of two similar paints, when applied rationally, is due more to the nature of their respective base, or to the better, or worse, quality of the materials ; that it is not due to differences in the proportions, unless these differences are quite out of proportion, and contrary to elementary practice. There will be occasion to return to this remark when discussing the proportions used by the Dutch Commission.

On the subject of the composition of the paints, according to the French Commission, it was wrong to invoke and test the proportions, which were not the work of practical men, but were built up from the conceptions of an engineer, Livache, who believed he had found the ideal, rational, and mathematical theory for adjusting the proportions in the composition of paints. Unfortunately for the Author of this theory, it was shown to be altogether incorrect, both by refutation of the calcula-

tions invoked and by the teaching of ulterior facts. Moreover, the Dutch Commission only quotes one formula of proportions for three coats, whilst there were at least five different ones for the experiments in question, since they operated at the Pasteur Institute:

1. On raw outdoor plaster.
2. On outdoor plaster *enduits*.
3. On outdoor woodwork.
4. On ironwork and iron plates.
5. Formulæ for *enduits*.

However that may be, and in any case, the French proportions for these experiments not being at all in conformity with the technique and practice of the painters of France, the Author can only repudiate, without any other motive, all the results which they have given, whatever they may be; but, as just said, the Author does not attach so much importance to the rigorous exactitude of the proportions in a paint, when it is a case of judging the intrinsic value of its colour and its base, because, in that case, operations are not confined to a single test, a single proportion, a single experiment. It was thus desirable that the Dutch Commission should not judge the French style of painting with white zinc from a single and unique formula, the more so as the mere examination of this formula denotes a complete aberration of technical skill, since the priming coat is found to contain four times as much oil as white zinc, not in volume but in weight; whilst not one of the first coats of white zinc, used by the Dutch Commission, reached even double the amount of oil in proportion to the white.

It stupefies the Author to find that it was possible, in the experiments of the Dutch Commission, to apply first coats with a liquid paint, containing four times more oil than paint, especially on wood. It was what might have been called a juice. What could such a coat do, as a foundation for other coats? The experiment was condemned beforehand. It was abortive from the start. This time, the difference in the proportions is far too great, and the Author protests and declares that it is not the French style of painting with white zinc. Such disproportions in a mixing can only lead to inferior results, compared with paints treated in a more rational manner. It is easily understood why white zincs, mixed according to the formulæ of the French Commission, behaved much worse than those made according to the proportions of the Dutch Commission, or even "that they weakened rapidly, and lost their appearance." It could not be otherwise, since their composition was abnormal, according to the sole formula for three coats, which the Author found in the Report of the Commission issued in October 1906.

The Author's own formulæ for such mixings are far, very far, from this so-called French formula used in the experiments of the Dutch Commission. The largest proportion of oil in such a coat (first coat on outdoor plaster) scarcely exceeds the equality of the amount of oil —115 of oil for 100 of stiff paint (115 per cent. instead of 400 per cent.). The second coat has 70 per cent., and the third 47 per cent., of oil calculated to the ground white stiff paint in oil. If there be added to these proportions of liquid, the oil in the stiff paint, say 15 per cent., there

is got, with the Author's most oily proportions, coats which contain exactly—first coat, 130 parts of oil for 100 parts of white powder; second coat, with 85 per cent.; and third coat, with 62 per cent. of oil to the dry colour. For outdoor woodwork, the Author uses less oily and less fluid coats; say, first coat 52 of liquid for 100 of stiff white paint (31 of oil, 21 of turps); in the second coat, 30; and in the third, 23 of oil for 100 of white.

If French practice in northern districts required a minimum of four coats, it is certain that the French proportions of oil would be slightly increased; but, with the French custom of working with three coats, it is better to keep the coats a little stronger in materials, if it be desired to cover properly. In any case, everything would remain greatly in the rear, with the fantastic proportions of liquid quoted above. A very interesting point, in the preceding considerations, is that which treats of the disintegration of white zinc which, when it is exposed, commences to break up between the third and the fourth year; and this disintegration goes on always increasing, until it destroys itself in a very short time, especially in the case of moisture (dampness).

The Author wishes, above all, to emphasise the lapse of time which the Commission assigns to the good behaviour of paintwork, placed not to be sheltered from all injury from the weather but sufficiently exposed thereto. Now, this same lapse of time has often been determined by the Author, and indicated as being the average duration of any given paint, provided its composition be rational, with good linseed oil as its chief binding agent. That lapse of time has already been

given in one of the chapters of this treatise—a chapter which was written long before he knew of the Dutch report, which came to him when the book was being paged, to support exactly his personal observation, which he is particularly pleased thus to see confirmed by experiments on the large scale, as momentous as official. The Author has always energetically opposed hasty judgments on all experiments in general. It is necessary to wait more than four years, for every paint may last as long as that, so long as it is applied in conformity with practice, as when it contains no ingredient destructive to oil. From the point of view of the respective behaviour of the two rival colours, the explanations of the previous lines in paragraph 12 are very suggestive; they are evidently inspired, and dictated, by the observations of facts; from which it appears to follow, so long as white zinc is not too much exposed, if no cause of deterioration supervene to destroy its nature, it may furnish a rather fine career; but, as soon as a cause of disintegration manifests itself, as soon as it gives way a little, this disintegration marches with rapidity. It is seen to give way slightly at first; then the pace accelerates; it gives way more rapidly, and continues henceforth without stoppage, always increasing, until the disintegration is complete. This finding is very just, very conformable with the facts of actual practice, and such that the Author can, personally, testify to it in several instances. Paragraph 13 is in contradiction with the above findings and explanations, and the Author makes no attempt to explain them.

In paragraph 1 it was found that white zinc, applied

on the large arch of the bridge, gave way more than the white lead and *even the lithopone*, and that, in consequence, it was undeniable that it had been washed off by rain. The reason given for this weakness of white zinc cannot be accepted seriously, since the different paints were equally exposed to the weather and to the smoke, during the course of their first application. Therefore, what was bad for one must have been equally bad for the other, and that one which suffered the most could not be, in sound logic, regarded as being better nor even equal to that which had not budged; and that the more so, as of these same paints, applied in a second experiment of separate plates, prepared and finished before being definitely fixed, it was still the white zinc which behaved the worst. From these concordant and searching facts, found on two occasions, it cannot be concluded that the rival paint, of white zinc, that which has resisted the same smoke and the same effects of sulphurous gas is equal to that which has given way. It should be acknowledged, quite simply and quite loyally, that it is superior as regards resistance. Moreover, when it is said of a paint, the cause of its less value in such an experiment should not be attributed to the quality of the material used, but to the effect of sulphurous gas, that amounts to recognising, implicitly, its less resistance to the usual agents of the destruction of paints, since another paint can resist them. In paragraph 16, as regards the vessel *Argus*, there is no occasion to raise serious objections. However, it is to be remarked that having been painted in 1904, this vessel was examined less than a year afterwards, then repainted in 1905. The duration of the first

paint was thus altogether insufficient to justify any decision whatever. After being repainted under the same conditions, with the same materials and on the same surfaces, it was found, four years afterwards, that everything was for the good, which was not at all surprising. The decision, in spite of everything, must be favourable to white zinc, and it declares that the latter always behaves a little better than white lead!

In paragraph 17, relative to the comparative experiments between red lead and red oxide of iron, the Commission declares its inability to decide the question of superiority between these two products, but it makes quite a stupefying remark in saying that it found it necessary to use more care, and to have more technical skill, in applying red oxide of iron than in applying red lead!!! There must be some printer's error there, for the Author refuses to believe that such a remark could possibly occur in so serious a report, but here is a peculiar statement: "Red lead dries very slowly," declares the Commission. That is a well-known fact; also in practice the drier is always forced in painting with red lead; but in examining the red lead paints used by the Commission, it is found that one of these red lead paints contains no drier. The examination of these mixings, given twice in the report of 1905, shows that there is no possible error, and that the two coats of red oxide of iron contained drier, whilst that one of the two coats of red lead is completely free; the mixing does not include it. It follows from this abnormal fact that, as regards the coats of red lead which were applied on the bridge of the West Docks at Amsterdam, there was as much drier as 14 per cent. of the weight of the

oil; and that for the coats of the same red lead, applied on the *bastinage* of the ship *Argus*, there was no drier. On the other hand, the two formulæ for proportions, for white lead, liquid paint, although both containing drier, contained it in very different proportions; thus the proportions which served for the coats, on the bridge of the lock of the West Docks at Amsterdam, contained drier, at the rate of 16 per cent. on the weight of the oil, and the proportions which served on the vessel *Argus* only contained drier at the rate of 5 per cent. of the oil contained in the liquid paint. The oil content of these liquid, red oxide of iron paints, is also very variable. The first contains 50 per cent., the second $62\frac{1}{2}$ per cent. of the weight of the red oxide. All these differences in the proportions, for paints having the sole and same object a common and unique destination—are they the work of chance or, rather, the result of a predetermined idea? It is impossible to say; in any case, no technical nor plausible reason can explain them.

The last line of section 17 suffices, in itself, to decide the question of superiority between red lead and red oxide of iron. In paragraph 18, as regards the *enduits* used by the Commission, the Author does not understand the composition of the white zinc *enduit*, where zinc oxide only figures in the proportion of 6 per cent. against 75 per cent. of Paris white and china clay combined with 16 per cent. of oil, 2 per cent. of turps, 1 per cent. of drier. It is certain that an *enduit* of this composition cannot run dearer than a white lead *enduit*. It ought even to run much cheaper, since the mixing formula of this latter *enduit*, likewise utilised by the Commission, contains twice as

much oil, three times more white, a fifth as much clay, and less chalk. This mixing formula of the zinc *enduit* almost exactly agrees with the French *molleton* or economic *enduit*, for rubbing down raw plaster, and no more than the latter should it be compared with a normal *enduit*, from the point of view of resistance and of solidity. Here follow the final conclusions, the most interesting and the most important, from the point of view to be decided.]

General Conclusions

The Commission is of opinion, that the following conclusions result from its labours:

I. White zinc paint resists sulphuretted hydrogen gases better than white lead paint. The latter, under the influence of these gases, rapidly becomes multicoloured and blackish, where much of these gases are produced; for instance, near certain canals, in towns, white zinc paint advantageously replaces white lead.

II. White zinc paints are not so resistant to the multiple effects of different fumes, containing sulphurous acid, as white lead paints. Where such fumes are produced,—that is to say, in the neighbourhood of locomotive smoke, factory chimneys,—white zinc greatly exposed to these fumes would be quickly corroded and *could not possibly replace white lead.*

III. White zinc paints, provided they be not exposed to the multiple effects of different vapours, from smoke containing sulphurous acid,—these paints in all their

applications, whether on zinc, cement, or iron (the latter having previously received coats of red lead or red oxide) resist in the open air for five years, as well as white lead paint, and can completely replace it.

IV. White zinc paints, provided they be not exposed to the repeated influence of sulphurous acid vapours or to great moisture, and applied on wood, iron, or zinc, on cement or plaster, behave as well as white lead for indoor work, and may completely replace it.

V. White zinc paints, provided they be not exposed to the multiple effects of the different vapours containing sulphurous acid, and are applied on wood, endure in many cases for five years in the open air, as well as white lead paints, and may replace them efficiently.

But on all spots where moisture accumulates, as on the ledges of windows, the under parts of cornices, etc., white zinc paint gives way, in an apparent manner, after three or four years, often even to such an extent that it becomes necessary to repaint the woodwork, to protect it afresh. *In this case it cannot compete with white lead paint.*

VI. White zinc paints, like those used by the Commission, cover at least as well as the white lead paints used in Holland. The white zinc *enduit*, used by the Commission, can be used just as well as the ordinary white lead *enduit*.

VII. The white zinc paint used by the Commission does not cost more on new outdoor work than the white lead paint used for the same purpose.

VIII. To repaint with white zinc paint on old outdoor work costs more than repainting with white lead paint, as the cost of bringing old white zinc painted woodwork

into a condition fit for repainting—that is to say, the cleaning, rubbing down, partial primings, are all more onerous than on wood painted with white lead, and which are again painted with the same white.

As regards painted woodwork, exposed out of doors, *white zinc paint may cost more*, if it be in a bad situation as regards moisture, because repainting must be done sooner than in the case of white lead. *Under such circumstances, the upkeep of woodwork painted with white zinc, exposed out of doors, is still further increased by this shorter duration than that of woodwork painted with white lead.*

IX. *Lithopone paints cannot replace white lead paint, for outdoor work. They are absolutely unfit for outdoor work.*

X. Above the water line, red oxide of iron paint has been found to be as durable and serviceable as red lead paint. Red oxide of iron cannot be used alone under water. Red oxide of iron paint costs less than red lead paint, but requires more technical skill for its application [!].

FINAL POINT OR CONCLUSION OF CONCLUSIONS

[The definite report of the Dutch Commission on these somewhat important experiments, as well conducted as scrupulously controlled, in no way solves the problem. It comes to no more definite conclusion, on the actual superiority of either pigment, than all the official reports made during a century on this question, on the possibility of the complete replacement of white lead by white zinc have done. As in all these reports, the theoretical mind

predominates in it, with its natural inclination in favour of white zinc, but also accompanied by the same restrictions, the same reservations, formerly made, which the observation of practical facts imposes in spite of everything. There is not to be seen in it any clear and positive assértion of the superiority of zinc oxide over carbonate of lead; but, on the other hand, the latter is never acknowledged to have given way, or even weakened, in any experiment, owing to atmospheric influences alone, as is formally recognised, in at least one instance, in the case of white zinc. And if white zinc in many cases, in almost all even, behaves, under the rubbing with the hard brush, just a little better than white lead, it must have been placed under more favourable conditions, sheltered from influences of the outdoor air. Its want of durability under the influences of sulphurous fumes and vapours is declared, in a very decided manner, as well as its fragility in contact with moisture.

As regards the Red Lead and Red Oxide question, the point raised as to the superiority of red lead and red oxide of iron remains, as before, without positive solution, at least in the eyes of the Commission. There is no definite decision, except as regards the point whether lithopone could be used for outdoor work. As regards this point, practice had long ago solved the question in the negative. The Commission, likewise, emphatically rejects lithopone for this purpose, and has nothing new of any good to say for it.

Summing up, this very conscientious report does not contain anything new, and does not point out any very striking facts in regard to the present controversy. It

does not tell us much more than we already knew as regards the intrinsic value and respective properties of zinc oxide and white lead. Nevertheless, its perusal is most beneficial, for very just remarks and interesting observations are to be found in it, from which the practical man can always reap some advantage. As a final point, the Author may say: If the conclusions of the Dutch Commission have not brought more arguments to bear against the opinions accepted by practical men, if they have not solved the question pending for decision, it is really because *the question is insoluble, in the sense or direction which up to now it has been absolutely desired to be solved.* After all, and according to the conclusions themselves, it is the thesis of the practical men which morally wins the battle against the thesis of the Academicians. The Author had no doubt but that it would do so.]

SECOND PART

CHAPTER IX

MANUFACTURE AND DIFFERENT TREATMENTS OF WHITE ZINC—ITS MODIFICATIONS AND IMPROVEMENTS

THE manufacture of white zinc rests, solely, on the oxidation of the metal, which is effected in two different ways: (1) In burning or distilling the vapours produced by inflamed zinc; (2) by direct oxidation of the fused metal. The first process is that invented by Leclaire, the patents for which he assigned to the Vieille Montagne Co. The second method was invented by Sorel, a clever industrial chemist and fertile inventor, to whom we owe, *inter alia*, galvanised iron. In Leclaire's process the metal is volatilised. It is placed for this purpose in special fireclay vessels, large retorts, or muffles, the number of which may vary, built in two rows, back to back, and so placed, in a reverberatory furnace; a small chamber, or "sentinel box," is placed in front of each muffle, and communicates from the top by a cast-iron pipe, with a system of condensation chambers, through which the air is drawn. In the bottom of each sentinel box is a mobile iron plate,

which, raised during the operation, lets in the requisite amount of air to burn the zinc; in front of each sentinel box is a door, for charging the retort and removing the residue after combustion. Once the retorts are charged with zinc, and after the enormous temperature of the furnace has brought it to a white heat, they give off metallic vapours, which pass into the sentinel box, where they are burned by the air which is brought there by the draught of the condensation chambers.

The oxide of zinc, so entrained by the current of air, is deposited in the chambers, all of which communicate with each other; the lighter parts of this oxide are entrained into the most distant chambers, and the heaviest parts condense in the chambers nearest the "sentinel box." This oxide is not so pure as the other. That which is collected in the most distant chambers may be regarded as *almost pure*; but its state of aggregation is not similar to that in the chambers nearer the retorts; and it is more flaky, lighter, and more impalpable. Its density is less, or, in common language, it has less body. The operation, therefore, yields two sorts of oxides, or rather two qualities of that oxide. The lightest is known as *snow white*; the heaviest is termed *white zinc*. There is even a third quality, formed by the particles of zinc, the oxidation of which is less complete, and which contains, besides metallic zinc in a very fine state of division, a certain proportion of other metals—iron, cadmium, arsenic lead. This quality is sold under the name of grey zinc [zinc dust].

Sorel's process is based on the direct oxidation of the fused metal. It economises fuel, and consists in heating

zinc in large muffles up to its fusion point, and then inflaming it by a current of air, which entrains the oxide into condensation chambers, communicating with the muffles. Contrary to the other process, the current of air only carries with it the purified oxide, or the snow white. But a large portion of the oxidised product remains on the surface of the bath of molten zinc, and even extinguishes it, if not constantly removed, by an iron rake. This oxide, which has been floated instead of entrained into the chambers, is eliminated from the muffles by a mechanical agitator, and falls into a reservoir. It is the sifted white, much less white than the entrained oxide, but the whitest portion is separated, mechanically, from the greyest, containing finely divided metallic zinc.[1]

It will be seen that in both of these processes there is always formed two products, differing from each other in fineness and in density, and that the operation always yields a utilisable by-product. The difference in their state of respective aggregation determines the difference in quality. The finest do not cover so well as the others, but they have the advantage over the latter of multiplying, of yielding more, in liquid paint. They are more bulky and weigh less ; consequently, the second class approach nearer to white lead, which, compared with white zinc, has more weight and less bulk. This confirms what has been said in the first chapter, under "Technical Remarks." The purest oxides are not always

[1] A third process, the so-called direct process, is described in Petit's *Manufacture and Comparative Merits of White Lead and Zinc White Paints* (Scott, Greenwood & Son).

the best, from the point of view of durability or covering capacity. The recommendation to use light oxides, rather than heavy oxides, is thus contrary to the principle of the durability of white zinc. The Author has already, moreover, enunciated the principle, which is the corollary of that which has been recalled above. The more a pigment approaches the metallic form, the more durable it is by itself; and if to that be added the property of assimilating with oils, it can only give the best results as a paint. Conversely, it may be said, the furthest away a pigment is from the metallic condition, the less actual durability it possesses. Hence the flakiness, the lightness, the impalpability are only secondary qualities, very appreciable without doubt, but only utilisable or indispensable in very fine careful work, or, more exactly still, as finishing coats in such class of work as has been said in the chapter on "Technical Remarks."

N.B.—Just as this book is being finished, the Author learns that a new method of manufacturing white zinc has been discovered and patented, which method is based on a wet process, which completely differentiates it from the two methods just described. This white zinc has been examined microscopically, and used practically by several Paris firms, and their testimonies, which the Author has read, are very favourable to it. It has the advantage of not throwing out the oil from the stiff paint, thus behaving in that respect like white lead and hydrated white zinc, which have only to be covered with water to preserve them.

Moreover, by this white zinc perfectly flat paints can be produced, without any difficulty, which is not the case

with the white zincs now in use, which require special precautions in producing a flat surface (*mat*). On the other hand, its whiteness is, it appears, superior to the most beautiful snow whites, and its fineness is remarkable. Is this the ideal product, the integral substitute, for white lead, the inevitable discovery of which, due to scientific progress, was prophesied by the Author? Time will tell. Up to now, the enormous cost of the plant for a suitable factory, for this style of manufacturing zinc oxide, the difficulties met with in finding the capital, and, above all, the stringent conditions imposed by an omnipotent contractor, are the causes which retard and will retard, for a long time yet, the appearance of this very much esteemed product, destined, undoubtedly, to have a most brilliant reception.

Alterations and Improvements in Manufacture—Driers and their Action—Methods of Grinding and their Practical Results—More or Less Successful Intervention of Water—Hydrated White Zinc.

The first white zinc manufacturers observed that it dried better after calcination; and Guyton de Morveau found that a small amount of zinc sulphate, added to the oil, remedied its slow drying. Much later, Sorel, to whom industry owes so many fine discoveries, also examined, and occupied himself with, white zinc, first with the process of manufacture, which rests on the oxidation of the metal, then with the drying of the oxide. At the time when Leclaire tried to conquer the difficulty in the drying of zinc oxide by treating the oil with black

oxide of manganese, Sorel, on his part, found that all the dried (dehydrated) salts of protoxide of manganese (all dehydrated manganous salts), mixed in very small proportions with white zinc, communicated energetic drying properties to the latter. These observations led him to prepare dry siccatives (driers), for painting with white zinc, by mixing manganese chloride with a given quantity of white zinc in powder, to avoid deliquescence of this very readily decomposable body. This was the starting-point of siccatives in powder. The composition of Sorel's drier was four or five parts of chloride for ninety-five parts of white zinc. This drier was used at the rate of 2 per cent., but it lost its properties at length, which is still somewhat the case with the dry siccatives of the present time.[1]

Barruel, a pharmacist who was in fact Leclaire's chemist, examining in his turn the salts of manganese, found that manganese borate, prepared in the cold, by precipitation of manganese chloride by borax, formed a very energetic drier. He found that 1 to 2 mgrms. of this borate, in white zinc paint, caused it to dry rapidly. But, owing to the drying of the oil, mixed with the borate, the latter decomposes somewhat, and assumes a brown coloration which may colour the paint. Barruel did what Sorel had done ; he mixed his manganese borate with white zinc, in powder in determined proportions,

[1] The Author found, in certain documents of this period, the description of a white zinc termed "siccative," and then sold in commerce under this last denomination, followed by these words, "Sorel's process," which seems to indicate that in addition to the siccative in powder this engineer treated white zinc to render it drying even during its manufacture.

and wrapped it in paper to preserve it, for the prolonged action of air and light is very injurious to this product. According to Barruel, a packet of 500 grms. (1·1 lbs.) of his drier sufficed, normally, to dry 40 to 50 kilos (88 to 110 lbs.) of white zinc paint. This rate of drying will be regarded as excessive, because, in these proportions, the oil was so drying that an excess of borate would in a manner start its combustion, which might very well seriously injure the durability of the paint. So the energy of this drier was reduced very greatly, so as to avoid accidents and mishaps. It is supplied, nowadays, of a strength of 3 to 5 per cent., instead of 1 to 2 thousandths, and it is quite sufficient.

In fact, the action of driers—termed energetic, rapid, extra-rapid, or sold under other descriptions of the same kind, whatever may be their nature — is to be dreaded, as all paint of every description, plumbic or zincic, should dry normally, that is to say, within an average period of time, keeping the right medium between extreme slowness and extreme rapidity. The average lapse of time for the drying of white zinc paint may be taken as between eighteen and twenty-four hours; to wish to go faster is to risk the result of the work. The best pigments are those which dry of their own accord; and without wishing to speak too much of white lead, which possesses this advantage, we can in summer make paints which dry in 8 or 10 hours, without the addition of any drier. Umber may be quoted, the natural drying properties of which are well known to painters. Now, umber employed, as it is dries very well, and does not crack; but if used simply, with drier in excess, it

cracks infallibly. This peculiarity is especially appreciable and noticeable in the use of glazes by decorators on wood when they prepare them for their outlines so as to dry rapidly, so as to be able to work above them next morning, or when the drying of the same glaze is pushed, so as to be able to varnish the decoration sooner.

On the other hand, Cassel earth, known for its anti-drying properties, cracks very easily, because the drying is always urged; used alone, it does not crack. It is, therefore, to the action of the drier, in both cases, that the cracking is due.

In a general way, rapid drying is abnormal, because the action of the drier produces on the oil a spontaneous oxidation, which is rather a combustion, the eventual effect of which is to modify the nature of the different compounds, which are in contact in a coat of paint, an alteration which prevents the normal physical phenomena from being produced, and which reacts also on the paint as a whole, which loses its suppleness, its elasticity, and the state of aggregation of which is partially disorganised, all of which, naturally, becomes very prejudicial to its durability.

How many mishaps—how many accidents, occurring afterwards, without apparent cause—are due to the immoderate use, or to a bad selection of driers?

It will be objected, that in these days one must get the job done quickly, and that driers are, in good faith, too good a help to be used with so much respect, so parsimoniously, for hasty jobs, which taking them altogether are the most frequent. The Author is, unfortunately, quite aware of it, and does not contradict this objection.

Only, in a book like this, which deals with first principles, technical popularisation, and practical principles, it cannot be a question of scamp work. The fact of being a technical author is not without its moral responsibilities, of which it is necessary to be conscious. It is necessary to show his trade, as it should be, and not as it has become, through a degeneration, which must be opposed at all cost, and, if we cannot prevent the evil, we can at least prevent the worst of this evil.

There is, thus, reason, as regards driers, to act prudently, and not to wish to cause two paints, one of which is naturally drying and the other is not endowed with that property, to dry within the same time. It is a material impossibility, and no one is bound to do the impossible.

Up to now, white zinc has always dried less rapidly than white lead. It will continue, probably, for a long time still to have this defect, which one can only expect to remedy partially, if it be desired to observe the laws of practice, and it is better to remain content with that, rather than wish to cause white zinc to dry as rapidly as white lead. Moreover, there is no need. When one can repaint, on a given coat, twenty-four or even thirty-six hours afterwards, it is a lapse of time altogether normal and propitious for the good execution of proper painting. On the other hand, as regards common work, one can, if need be, be a little more empirical, and hasten the drying, so as to be able to repaint in twelve to eighteen hours afterwards; but it is well understood that this will always be to the detriment of the beauty of the appearance and the durability, especially when it is a case of

white zinc, the use of which is always more delicate than white lead.

Grinding.—We must now examine another point, more important perhaps, as regards the improvement of white zinc than is the addition of drier to a paint. This important point is the grinding. Without proceeding further in our explanations, it may be laid down, as a principle, that the more care exercised in grinding a paint the more fit it is for use as a paint. The chief effect of grinding is to amalgamate the pigment, intimately, with the oil, so as to form with it a homogeneous paste (stiff paint), whilst, at the same time, it imparts to the paint the fineness and unctuosity indispensable for its good application. In this respect, all paints in general are indebted to mechanical grinding for the three properties about to be named—homogeneity, fineness, and suppleness—counting also the economy which results, because a perfectly ground paint goes much further than another, the grinding of which has not been pushed so far.

But when it is a case of a basis paint, like white lead, white zinc, or even lithopone, the question of grinding assumes still greater importance, which may even be termed capital; and although this operation be, in itself, one of the most simple, and which does not seem to require any very special, or very different, turns of the wrists, yet there are certain methods of working which directly and considerably affect the material ground, especially white zinc, the process, or rather the manner of grinding, of which often brings about a very great improvement in its covering power, which is what is about to be demonstrated. Here is, first of all, as regards

paint grinding, what the Author wrote in an article in the *Journal des Peintres* (the organ of the Federation of Belgian Master Painters), to which he contributed for several years, so long as the management was impartial, intelligent, and really confraternal. Extracts from this article appeared in the issue of 25th March 1910, under the title, "There is Grinding and Grinding."

"Grinding is a very important operation, which deserves to be taken seriously. It is to it that the greater part of the raw materials owe certain of their respective qualities, and through it that they are able to yield fully what they are capable of doing. It is, so far, true that the writer was able, last week, to prove it in a very suggestive, although well-known, way. On two successive reprisals, he convinced an incredulous person, by proving to him that two stiff white zinc paints, having the same origin and manufactured by the same process but ground in a different manner, behaved very differently when made into paint, the one covering much more than the other, whilst at the same time it was more unctuous to the touch, more flowing in use, and went perceptibly further. One would have imagined that two different products, as regards origin and manufacture, were being used. One of these stiff white zinc paints had been ground in a special industrial factory. The other had been ground in a paint workshop (Leclaire's), and this latter stiff paint was better than the first. Although there is nothing very new in this fact to many painters, there exists, however, a large enough number of painters who do not sufficiently realise this truth, and who would be sceptical enough to doubt it, and to imagine in themselves that it is very

strange, that so very great a difference exists between two samples of the same paint, due to the difference in the respective methods of grinding; and yet, as a matter of fact, it is so. But some one will say, why this enormous difference? It can at least be explained. Evidently so; it is even with this object that the present article has been written, and it would not have been written if the Author had not been able to name the cause which produces the effect. Moreover, the Author always believes in going to the root of the evil of the abuses and prejudices, so as to deduce from them the method of treatment, curative or preventive, as the case may be, and often even both, at once. It is the only method of working profitably. . . . The essential object of grinding is to obtain perfect homogeneity between the solid pigment and the liquid vehicle which serves to it as binder, the latter requiring to be intimately incorporated with the former, this is effected by the complete crushing of the pulverulent molecules, which with the same stroke are not only enveloped in a simple mixture, but penetrated by liquid molecules, the whole forming afterwards a complete aggregate, as inseparable as possible—in a word, perfectly homogeneous. To secure this result, there must be taken into account certain obligations, certain necessities, and circumstances, which simple good sense suffices generally to indicate, but which, unfortunately, are not sufficiently taken into account in actual practice, paint factory practice especially, any more than amongst painters who grind their paints directly in special factories termed factories of improved grinding.

"Is it not an elementary principle, that pigments in pow-

der, of whatever nature, should above all be completely anhydrous, *i.e.* free from water, and even from any trace of moisture, so that the oil added to them in grinding may penetrate, readily and intimately, throughout their whole mass?

"On the other hand, it is no less important an elementary principle, that the liquid binder should be at a normal and regular temperature, so as to preserve its elasticity permanently; for a lowering of the temperature, especially by a somewhat abrupt transition, causes it to contract, to shrink, and that hardens it a little; in any case, it removes from it a good part of its fluidity and elasticity. On the other hand, an abnormal elevation, or more or less abrupt rise, of this temperature, increases its fluidity, relaxes it, and sometimes causes it to string. In both cases, the grinding is defective. The choice of binder, again, is important, for according to the class of pigments to be ground, and according to the nature of the oil used, the excellence of the result may be compromised. As a proof of this, the Author need only point to the prolonged groping in the dark, which existed and which still exists in certain factories, as to the nature of the oil to be used in the grinding of white zinc, white lead, and even ochres.

"In the grinding of white zinc, linseed oil was used, as in the case of white lead, but it was gradually given up owing to the coloration which it imparted to the paint.

"Linseed oil was replaced [in France] by poppy-seed oil, which preserves all the whiteness of the zinc oxide. But, within the last fifteen years they have resumed the use of linseed oil, as drying better, and some even declare that it covers better! The Author does not certainly undertake

to support this argument. In his time, several grinders have returned to poppy oil, so that there are to be found in the French paint trade, white zincs ground in white oil, and other white zincs ground in linseed oil [raw]. They also use, or are now trying to use, decolorised (bleached) linseed oils, which are greatly puffed by certain oil-merchants, and greatly run down by others, which proves that the nature and quality of the oil binder in grinding is far from being indifferent.

"So much for white zinc. As regards white lead, it is almost the same. When its direct grinding with linseed oil was suppressed, as a hygienic measure as much as an economical one, by previous grinding with water, followed by a process of natural substitution of the oil for the water, by a phenomenon of special capillarity, they groped in the dark, likewise, in the selection of the oil; but as it was found that the affinity of white lead for the oil was greater for poppy oil than for linseed oil, only poppy-seed oil was used in [French white lead] factories; and it would appear, moreover, that this substitution has caused white lead to lose a part of its covering power. This supposition is far from being demonstrated. The Author's personal observations in no way confirm it. In any case, he believes to have pointed out in the preceding, that there appear to be three essential points to watch during grinding: (1) Absolute dryness of the powdered pigments, (2) normal and uniform temperature of the binder, (3) judicious selection of oil, in regard to the substance to be ground. There may be added to these points—the exact and invariable proportions of the raw materials, solid and liquid, and finally the proper turn of

the wrist (knack) for grinding, which consists, especially, in the perfection of the regulation of the grinding machines, in the speed of their rotation for a normal output, which must never be exceeded, under the penalty of losing, at a single stroke, all the good results of the best attention and the best appliances.

"In a painter's workshop, grinding, provided it be done seriously, can and should be better done than in a paint factory, where, in spite of the most improved machinery, they are always inclined to cause the machines to yield a maximum of work, without any other thought than of coping with the abundance and superabundance of orders.

"The paint manufacturer grinds to sell. The more he grinds, the more he sells. The painter himself only grinds to paint for his direct needs; he takes his time and his precautions. The former has no thought but of producing; he accelerates the speed of his production up to the extreme limit of the capacity of his machinery. Now, acceleration of speed of production is always made to the detriment of excellence in grinding. The Author is far from having any intention of accusing paint grinders. He simply makes a statement and a comparison, which may be profitable to those interested. Moreover, at the risk of his relations with certain manufacturers, he submitted criticisms and remarks of this nature to them, which were always received with good grace, and regarded as being within the measure of the possible. The Author believes that friendly intercourse is not frequent enough between painters and their purveyors, because such friendly intercourse would allow

of an exchange of views entirely favourable to their reciprocal education and instruction.

"During grinding, it has been said, that the intensive acceleration of the production, or, if preferred, the over-production, is always secured by the deterioration of the excellence of the result. In fact, as soon as it is desired to exceed the average normal production, there is a rupture of equilibrium between the different requirements, of good work—certain phases of the operation are only accomplished imperfectly; and, during too rapid or too intensive grinding, unfavourable effects are produced, which, if not immediately perceptible, none the less exist, with all their eventual and ulterior consequences.

"To quote only the chief causes of these bad effects, take, first, the too great speed of rotation of grinding machinery in general, and grinding rolls in particular. In certain factories it is held that once the different organs of the machine are well regulated there is nothing further to do, but *roll*, *roll*, *roll*, and that the output of paint may be pushed with impunity, by increasing the speed of rotation of the rolls, by changing, if need be, the diameter of the driving pulleys. No account is taken of the fact, that the increasing or continuous rapidity, at an excessive speed, increases the energy of the friction, which generates heat, heats the rolls, and that this heat is communicated to the paint, and acts deplorably on its composition. To secure rational grinding, it is necessary, at all cost, to avoid heating the rolls or grinding stones, so as to avoid all heating of the stiff paint; and, moreover, it is necessary to allow the latter a certain lapse of time between the different phases of

the operation; between the mixing in the pugmill, and the first grinding; then between the latter, and each of the other grindings in succession. If the rolls — at full speed — may reach a certain temperature, they must not be allowed to get positively hot, so that it cannot be borne by the hand in contact with the metal, as the Author has found during some inspections, where the rolls showed a heat of 60° to 70° C. in the stiff paint, as it issued from the rolls. This defect in the machines has been so well understood, that there are to be seen, in factories anxious to turn out good work, hollow rolls, fitted with water circulation in their interior, with the sole object of providing against their heating, and to maintain them regularly at an average temperature.

"It follows from these remarks, that the speed of rotation of the rolls of a paint grinding machine may be calculated and regulated in such a way that they cannot heat. The work may not be done so rapidly, but the grinding is rational and proper.

"In the same way, all simultaneous or continuous grinding, without stoppage, from the mixture of the oil with the dry pigment [in the pugmill], then through the first and the second grinding, without the stiff paste getting any rest — such a style of grinding is abnormal, and prejudicial to the quality of the paint so obtained. Rational grinding is that which is carried on, in succession, in an intermittent manner, at different times, and not the three operations simultaneously, on the same so-called improved machine, the sole improvement of which is its big output. This system, however well regulated,

however well conducted, it may be, will never equal the more onerous and more rational one just mentioned.

"If it be important to search for fineness in the stiff paint, it is likewise important to watch that the physical nature of the paint be not altered in the wrong direction. Rapid grinding, and especially consecutive grinding, produces an excessive heat, which is by far the best agent of molecular alteration, and to alter the molecular condition of a compound is to destroy its rational composition."

The force of this [magazine] article remains now, more than ever, and the Author sees nothing in it to retract. One is not accustomed to listen to remarks of this nature, and painters, like manufacturers, are for the great part indifferent thereto. These are, however, matters which must be mentioned and propagated amongst paint merchants, who only know one way of selling their goods. They spread out, over a knife, in front of the painter, a sample of white zinc paint, lithopone paint, or white lead paint. They draw attention to its fineness, whiteness, and firmness, and what a nice state of affairs it is if the stiff paint, after cutting, acts like rubber, agglomerates into lumps or strings with the spatula! The stiff paint, above everything, should not shift, solidify, nor soften with the weather; it should, in one word, remain homogeneous.

Intervention of Water — Hydrated White Zinc. — The possible modifications in the physical nature of ground stiff paint in oil have just been described. Let us go further, but more particularly as regards white zinc, the study of which is the special object of this treatise. If the heat produced by intensive and consecutive grinding is one cause of alteration in the nature of white zinc,

freshness, moisture, or, better still, contact with water is also an essential cause, determining eventual modifications; but, by the direct intervention of water, these modifications are rather favourable to white zinc, at least as regards its covering qualities, which are increased. The following passages are borrowed from Stas, a grand Belgian chemist. They were inserted in his famous and luminous Report to the Jury of the International Exhibition of 1865, on white lead paints as compared against white zinc paints. The Author does not hesitate to say, that Stas is his chosen *authority*! But if he be quoted, almost exclusively, it is because he is the sole author who has scientifically explained the physico-chemical phenomena, which are manifested by these two products, used as a basis for paints; and it is not the Author's fault if Stas's conclusions are, in almost every instance, in conformity with the practice followed by painters from all time, and if they frequently show to their well-known critics that the practice of painters is correct. As a true man of science, this distinguished chemist has not passed over any of the properties of white zinc. He has even indicated facts, which should occur, under certain given circumstances, and he has always made a reserve for the future, as regards the eventual modifications of this product. These modifications, foreseen by him as will be seen, are now in the way of being well and fully realised; they will help more than anything else the diffusion and general acceptation of white zinc by painters remaining hostile to its use.

"The calcination of zinc oxide perceptibly increases its covering power. The action of water on this white

is especially remarkable in this respect. When a paste is made with white zinc, with water, and after it has remained in contact with it for some time it is made into cakes which are dried in the stove, a mass is obtained which possesses a greater density than the oxide used, hard to grind, very faintly yellow, re-becoming perfectly white in contact with water, and covering much better. House painters that use white zinc know that in mixing water with the oil for the preparation of their stiff paint the latter takes much less oil to be brought to a fit state for use.[1]

"On the occasion of the examination of the products exhibited by De Launay, Druzon, & Co., it has already been stated that these manufacturers had reduced the amount of oil by one-half, by first making a stiff paste with water. It is therefore certain, that this simple contact with water may change the physical condition of white zinc." It may be added, that the lighter it is the more perceptible is this change, owing to the increase in density from this hydration. It is true, declares Stas, "that certain painters assert, that the paste of white zinc, into which water has been made to intervene in the grinding hydrated white zinc, yields, after complete elimination of the water, a paint very liable to crumble (*fariner*). It is none the less true, that contact with water changes the physical state of white zinc, and increases its covering capacity. This is a point worthy of examination,

[1] The document dates from 1855, and white zinc was then used somewhat frequently as powder. Painters mixed it themselves with oil at first into stiff paint, then to make their liquid paint, but the great thirst for oil which white zinc possesses induced painters to find out the economical method—that indicated by Stas.

interesting in the highest degree to painting in white zinc."

Ah, well, why during this interval have not manufacturers tried, on their part, to increase the covering power of white zinc? Are they, like cats, afraid of water?

All of them, however, have not had this fear of water, as there has now been on the market for some years a HYDRATED white zinc, which white zinc is so far changed in its physical state as not to reject the oil from the stiff paint — a well-known drawback of all white zincs—and to preserve which in oil, it has only to be simply covered with water like white lead. That is a very interesting fact, of great advantage to the painter, who justly complains that the white zinc usually supplied to him must be covered with oil, which renders it, the product being already inclined to greasiness, still more oily. But the point is to know whether the hydrated white zinc, now on the market, is not rendered too poor in oil, owing to its percentage of water, and whether the paints in which it serves as a basis are not, in virtue of this fact, liable to crumble (*fariner*) after the drying and resinification of the oil. The Author must acknowledge, that after the determinations made on work excuted four years ago with this special white, by master painters worthy of confidence, the defect of crumbling has not manifested itself up to now; and for his own part the personal tests of the Author, too late and too recent, do not allow him to conclude *for* nor *against* this eventuality, which however remains a theoretical possibility. Moreover, as regards outdoor painting like that referred to, it is to be believed, that their oily composition must necessarily

sustain them during this lapse of time (four years). One can hardly hope to give a useful decision in such cases until after five years at least. The same determination may be effected much more quickly in indoor painting; in flat tints, two or three years suffice.[1]

These conditions form, precisely, part of the modifications foreseen by Stas about sixty years ago, and which we are about to give as fully as possible. For that purpose, it is necessary to present the thesis published by that eminent chemist—a thesis which belongs to him alone, and which may with good reason be regarded as exact—first, because no other thesis has come to contradict it; again, and especially, because it corroborates, almost completely, the observations of practical painters, in regard to the particular, special, and different uses of the two whites—white lead and white zinc—as well as the different manner in which they behave when they are

[1] The Author profits by this remark to observe here, in a general way, that the several practical experiments attempted, invoked, or quoted, in the course of the campaign in favour of white zinc, were judged too soon; for every paint, however inert it may be, provided it be mixed with good linseed oil, can and should yield paint which resists out of doors, in average weather, three to four years. That is the normal time which a good oil takes to resinify completely. It would therefore be necessary, in order to form a sound judgment, to extend the date of the examination of these different tests. That of the definite examination of the Institut Pasteur, fixed five years after their execution, was in absolute conformity with this requirement. Unfortunately the tests were owing to an error, and a doubt, annulled, in their most interesting part, and the one which ought to have been the most conclusive. That is why the Author has given an account of the official experiments of the Dutch Government, both from their importance on surfaces of every nature, and from the point of view of the identical lapse of time allowed to form a definite judgment.

both exposed in similar circumstances and situations. Stas lays down this principle—that, in white lead painting, the oil and the pigment uniting combine chemically, then finish, after drying, by forming a special compound, lead oleate, homogeneous, and inseparable; whilst in painting with white zinc, there is no combination, but simple mixture, always separable. He explains these two facts thus:

"Liebig was the first to show that lead oxide can dissolve in a somewhat large amount of linseed oil without saponifying it.

"Linseed oil thus acquires very drying properties; the secular use of oxide of lead to render that oil more drying more than proves the fact.[1]

"At the ordinary temperature, and especially at a high temperature, linseed oil may, likewise, dissolve the basic acetates, lead salts, and even the neutral acetate of lead. The solution of acetate of lead in oil, when it comes in contact with air, disengages acetic acid at the ordinary temperature.

"The oxide of lead dissolved in oil, whether by digestion with the anhydrous or hydrated oxide, or by contact with acetates of lead, saponifies it after a certain time, because it contains a certain quantity of water. Linoleate and margarate of lead are thus produced, which, being soluble in oil and in very considerable proportion, the linoleate especially, as I have satisfied myself by direct experiments, remains in solution.

[1] The use of litharge boiled oil, the so-called plumbiferous oil, for the manufacture of varnish is a proof of this fact; but such oil is also prohibited by the French law prohibiting white lead.

"Linseed oil, holding in solution either oxide of lead or linoleate or margarate of lead, in greater or less amount, dries in contact with the air. The oil which contains the dry oxide dries sooner than that containing the linoleate or margarate of lead; but both the one and the other, applied on a surface, form, after the oxidation of the oil, a plumbous varnish, dry to the touch, transparent or milky, or even white and almost opaque, according to the amount of linoleate or margarate dissolved.

"This varnish exhibits great elasticity, and resists rubbing better than that obtained by dessication in the air, of oil which does not contain lead. It contains linoleate and margarate of lead intact, which can, by suitable solvents, be separated from the oxidised linseed oil, which becomes insoluble, as we know.

"Let us now apply these facts to the preparation of stiff white lead paint in oil. When it comes to the mixing and the subsequent grinding of white lead with oil, a portion of the hydrate of lead and of the acetate of lead which are contained therein (*i.e.* in the dry white lead) dissolve in the beginning. By allowing the paste to stand by itself, out of contact with air, a fresh and larger amount of lead oxide is dissolved. Thus we know, that white lead paint, preserved under water, or in a closed vessel, ends by becoming tacky. The tackiness of the paste is generally attributed to the rancidity of the oil alone, but we (Stas) have determined that this gluey state is due principally to the formation of a lead soap, which dissolves in the oil.

"When it comes to thinning down the stiff paint, in a suitable quantity of oil, to render it fit for use, and when

such paint is afterwards applied on any given surface, it dries, owing to the air, and the coating consists essentially of carbonate of lead, containing a little hydrate of lead. These particles of carbonate of lead, a white opaque body, are enveloped, even soldered together, the one to the other, by the margarate of lead, which imparts opacity and elasticity, and the linoleate especially much impermeability to the coat.

"When the paint is exposed to the causes which in general destroy it most rapidly, such as the direct rays of the sun and moisture, the oil, which has become oxidised, is consumed; but the destruction thereof is delayed, by the impermeability of the lead compound which it contains, and which covers it. Under the influence of the rises and falls (changes) of temperature the paint is less liable to crack, split, and to fall off in scales, owing to the great elasticity which the linoleate and margarate of lead impart to the oxidised oil.

"White lead, therefore, contains in itself the cause of the drying power which it communicates to the oil. It cedes the oxide of lead to the oil which produces this effect. This oxide of lead, by gradually saponifying a certain amount of oil, forms a metallic salt, soluble in the oil, which remains dissolved after the oil has dried, and communicates to the substance, which results from this oxidation, both elasticity and permeability.

"White lead, therefore, owes to the chemical nature of the compounds which it contains the cause of the permanency of the paint into which it enters.

"Let us see what takes place when zinc white and oil are mixed, and when such a paint is exposed, so as to dry

after being applied on an object. The zinc white suspends itself in the oil, but however long may be the duration of the contact of these two substances, whether there be presence or absence of air, whether the oil be fresh or recent, *under no circumstances whatever does any appreciable quantity of the zinc oxide dissolve in the oil.*"

"If water be made to intervene, and the contact between the oil and the white be prolonged whilst slightly elevating the temperature, a very small quantity of the oil saponifies; the linoleate and the margarate of zinc, products which dissolve in the oil whilst hot, *never remain dissolved in the oil after cooling.* By directly bringing linoleate and margarate of zinc in presence of oil, at a high temperature, these zinc salts dissolve in greater or less amount, but separate entirely out on cooling, to such an extent, that the oil in this case scarcely contains more than two parts in a thousand of zinc oxide in solution. Thus, as far as regards the circumstance in which paint is made and used, it may be said that zinc oxide as well as zinc linoleate and zinc margarate *are insoluble in linseed oil.*

"Linseed oil, which has been in presence of zinc oxide, and in which linoleate of zinc has been dissolved, dries no better than linseed oil before its contact with these substances.

"By mixing linseed oil, zinc oxide, and borate of manganese, and abandoning this mixture for several days in contact with air, the oil decomposes borate of manganese, and dissolves the protoxide of that metal. Such oil may thus take up as much as 2 per cent. of that metal. It forms a liquid with a feeble yellow colour, which, left in

contact with air, oxidises very rapidly, and precipitates sesquioxide of manganese, which colours the solid matter intensely brown. Under such circumstances, *no trace of zinc oxide is dissolved in the oil.*

"The linoleate and the margarate of the protoxide of manganese are very soluble in linseed oil; the solution, which is colourless, becomes blood-red in contact with air. In this condition it dries rapidly, and communicates this property to linseed oil. It dries to a red transparent varnish.

"If we deduce from the preceding facts what ought to occur in the preparation and the drying of zinc white paint, and the chemical nature of the coat, after drying, we arrive at the following result: Paint, made with the help of a drier, contains, as has been said, traces of linoleate and margarate of manganese; the oil solidifies, enveloping the particles of zinc white, but the solid substance produced, only containing traces of manganese soap, presents the properties of linseed oil which has been made to dry after incorporating an inert body therewith. As oxide of zinc does not dissolve in oil, the traces of manganese, which it has been found possible to dissolve therein, have simply rendered it siccative; and, on the drying of this paint, it only consists of zinc oxide, a covering body, but in any case deprived of the essential elements of durability.

"Has water been made to intervene during the grinding of the paint? In that case, the zinc oxide, interposed in the dried oil, may be mixed with a certain quantity of linoleate and margarate of zinc, but these salts remain, like the zinc oxide itself, outside the substance of the

oxygenated oil, because they were insoluble in the oil, in the conditions in which the paint was applied.

"The difference which exists between the chemical nature of white lead paint and white zinc paint, therefore, explains why these two paints, both exposed to the same destructive influences, behave and must behave differently."

These certainly are scientific explanations, delivered in a masterly manner, which throw great light on the eternal question of the competition between the two paints which form the basis of house-painting; and no similar examination has been published since the appearance of this one, which, however, dates from more than half a century ago. Stas ends his explanations by a phrase, which may be regarded as the summary of his thesis, namely, that it is to the absence of a proper amount of metallic soap, dissolved in the oil and forming a metallic salt in white zinc paint, that the latter does not possess the elasticity, the impermeability, and the resistance, which white lead paint undoubtedly possesses, which owes precisely these qualities to the presence, in considerable quantity, of lead salts, *which are dissolved therein, and which remain dissolved in the conditions under which paint is applied*; but, adds Stas, "in the interior of houses and edifices, where the destructive atmospheric agents do not act at all, or at least only act very feebly, white zinc paint, like all paints made with linseed oil, and some solid body, which does not of itself induce the destruction of the dried oil, may be employed with the greatest advantage; and its rôle will always be so pretty, that one can say that its manufacture at a moderate price and its

application as a paint forms one of the glorious conquests of the century." Finally, showing how white zinc was capable of improvement and having no doubt of the progress of industrial chemistry, or of human genius, Stas wrote, "If we do not abuse the rôle which white lead plays in painting, the oxide of lead which becomes soluble passes to and remains in the condition of linoleate or margarate of lead in the oil, before and after its drying; it ought to be possible to make by means of white zinc, or any other inert matter, and linseed oil, in which there has been directly dissolved a proper amount of these lead soaps, or any other white metallic linoleate, possessing the properties of linoleate of lead, a paint which stands out of doors as well as white lead paint, although paint of this nature must be affected by sulphuretted emanations; none the less, it is of great interest, that this experiment be tried on the large scale."

This was to indicate, in very modest language, the methods to be used to endow zinc oxide with the properties of durability which it did not possess. Stas, in fact, demonstrated theoretically that in preparing oils, saponified by lead salts, and utilised, either in the grinding of the white zinc or in the composition of the liquid paints, we ought to obtain zinc paint as supple, as impermeable, as resistant as may be desired, and yet no manufacturer has dreamt of pursuing this path, all mapped out for useful researches. It took nothing less than the long and weary campaign against white lead, of 1900 to 1909, to induce the manufacturers of white zinc to make researches with a view of improving this product; and it is only in the later days of this

campaign, that some new if not fortunate attempts were made.

The Hydrated White Zinc now on the Market.—Amongst these different attempts, that of Georges Petit is to be specially distinguished, because it attacks the sole question to be solved. Modify white zinc in such a way that it may possess, in itself, all the practical advantages and properties which it is blamed for not having. The problem has been enunciated; it is wholly comprised in the data and the theory of Stas; and although Petit declares this theory false, it is none the less on it and on its data that he bases his system of manufacture of hydrated white zinc, of which he is the inventor—that is to say, the saponification of the oil, or the formation of metallic salts, dissolved therein. Petit would appear to have tried to exceed by far the hopes of Stas, who hardly saw the possibility of the saponification of the oil and the presence of metallic salts in a paint, except in utilising the combination which he had described, such as the lead soaps; whilst the inventor of hydrated white zinc declares it possible to bring about and obtain this combination by zinc soaps. For that purpose he utilises the effects of water in hydrating white zinc when it is being ground, as Launay, Druzon, & Co. had themselves done fifty years ago as a matter of economy, whilst he did it to obtain the saponification of the oil forming the metallic salts of which Stas speaks, and to the absence of which he attributes the want of elasticity and impermeability. He had, however, shown that these salts might be obtained in very small quantity by increase of temperature in the course of a laboratory experiment,

but they do not remain in solution in the mass after cooling, and that they were thus non-existent or of no effect, under the conditions in which paint is generally used. Now with hydrated white zinc we have to deal, according to Georges Petit, no longer with a simple mixture of oil and oxide of zinc, but with a new compound resulting, as in the case of white lead, from a chemical combination, which itself results from the generation and the presence, by the wet way, hydration of a zinc soap, in the ground stiff paint; this is, at least, the way in which the phenomena can be explained—that is to say, the possibility of a combination between the oil and the white zinc, a combination which the inventor asserts exists actually, and which is created by his method of hydration and grinding, applied to ordinary commercial white zinc. Now it is necessary to know whether the salts of zinc obtained by this method remain dissolved in the oil, after as well as before the drying of the paint, for if they do not remain in solution in the liquid paint, or if they separate from the oil, through drying, the necessary conditions for the chemical combination are not fulfilled; and in that case we would still have to deal with a mixture of inert matter in the oxidised oil, with oxide of zinc, in powder held in suspension in an oily binder, the sole agent of durability and resistance. It is for time and practical observation to elucidate this capital point, the most important of all, and if the assertions of the inventor of hydrated white zinc are confirmed, and controlled by future facts, it can be said, in the near future, that it is to the French campaign against white lead, and which the Author

Fleury] opposed, that we finally owe the discovery of n ideal product, a real substitute for white lead in all s forms, with the property of being harmless, from a ygienic point of view, which was wanting in white lead, ıstly accused of being a poison, which no painter has isputed, because it was from all time an indisputable ruth. As far as the Author is concerned, he fervently opes that hydrated zinc oxide fulfils all its promises. 'he reality of its discovery would then be a real humani-arian blessing, because it would permit of the abandon-ıent everywhere, without any regret, of the use of a ery noxious pigment, which was only employed so long, hrough the want of a similar product having the same ombined practical and economical properties.

But has Georges Petit by his scientific treatment of inc oxide succeeded in filling the gap by supplying to ıydrated white zinc these two indispensable properties? 'heoretically, yes, but from a practical point of view an nfallible decision cannot yet be given ; because, whatever t may be during an average period, the beautiful ap-earance and condition of the practical trials made with paint product, it is necessary at the outset to multiply hese experiments, and then leave them plenty of time o produce all their effects. Now the lapse of time ecognised as necessary to this manifestation comprises minimum period of five full and complete years, at the xpiry of which one can hope to be able to give a decision n conformity with the truth. This delay is, here, still nore necessary, as it is a case in point of a pigment vhich has to be used as the essential basis of paints and riming coats in building construction. Therefore, do not

let us shout victory too soon, for, after five or six years' practical experience with hydrated white zinc, it will be necessary to know if the latter behaves not as well but much better than non-hydrated white zinc. Such is the material proof to furnish, the more so as it is asserted that the white zincs (ordinary oxides) judicially used behave very well for four years and even longer. Under such circumstances hydrated white zinc to be declared the best must, above all, show itself superior to all others by its longer life and its greater permanency.

CHAPTER X

THE LEGISLATIVE HISTORY OF WHITE ZINC PAINT

THE poisonous properties of white lead occupied the attention of investigators for a long time, but so long as the use of paint in buildings was somewhat restricted, few efforts were made to substitute any other basis colour for white lead. It was only, in 1779, that Courtois, a manufacturing chemist attached to the laboratory of the Academy of Dijon, discovered not white zinc but the property which it possessed of not blackening under the conditions in which white lead blackened. A little later, another celebrated chemist, Guyton De Morveau, who collaborated with the illustrious Lavoisier in creating chemical language, was the first to propose to replace white lead by zinc oxide. In painting, he pointed out that white zinc did not dry so well as white lead, and observed, on this point, that, by adding to the white zinc paint a small amount of sulphate of the same metal, this drawback was partially remedied. At this time, Courtois, seeing himself encouraged by such a scientific authority, undertook the manufacture of white zinc on the large scale; then he established retail shops, in Dijon, and in Paris itself. The first applications of

this paint were made in artistic painting; as regards house-painting from the time of the trial made in the beginning it was the object of severe criticism. It was blamed for not covering as much as white lead and for drying much less rapidly. These criticisms, which are still formulated at the present day, were nevertheless contested at this time, not by a painter, but an artist painter, Montpetit, who tried to refute the assertions of house-painters, whose trade practice was, necessarily, quite different from artistic practice. Montpetit sent a memoir, refuting the criticisms of the painters, to the Royal Academy of Architecture of Paris, which nominated a Commission. The latter made a report, entirely favourable to the opinions expressed by the author of the memoir, and, therefore, contrary to the opinion of practical painters and to their criticisms. This was the first conflict between the theoretical men and the practical men, and it was destined not to be the last. Following up this report of the Academy of Architecture, the Ministry of Marine made experiments on the large scale with white zinc paint, in the interior of the vessel *Languedoc*; and a Commission, nominated to examine the paintwork, likewise pronounced in favour of white zinc. On this advice, Marshal De Castries, then Minister of Marine (1782), decided to adopt white zinc for the interior painting of the Government Navy. This first Commission of examination, and this first ministerial decree in favour of white zinc were destined in the future to have numerous repetitions. All these facts concerning white zinc, from 1779 to 1782, experiments, reports, and commissions were already public property in

France, when an Englishman, Atkinson, took out in 1786 a patent for the manufacture of white zinc, and its use in painting ! ! ! But Guyton de Morveau, roused at such audacity, claimed for France the priority of this discovery. He succeeded, as was only just. At the same time he returned to the question, making personally or in collaboration with Courtois, strenuous efforts to launch the new product, to the popularisation of which he devoted from 1786 to 1802. But, in spite of his efforts, white zinc did not, however, enter into the practice of painters. The question was buried, and was not resurrected until 1808, in connection with a report on the paint products, which one Mollerat presented to the Institut National (Academy of Science)—products which, he declared, were manufactured by quite special processes. It was the renowned chemists, Fourcroix, Berthollet, and Vauquelin, who were entrusted with the report on these products, amongst which white zinc figures. These grand men of science prepared a report of remarkable precision, and their decision, although more than a century old, still retains its force to a great extent. The defects with which white zinc is blamed, they say, are so unimportant, compared with the drawbacks of the present use of white lead, that one cannot, reasonably, refuse to adopt it. The liquid paints which it gives are more pure, more clean ; its lustre, if it be less brilliant, does not tarnish. In equal quantity, it covers a greater surface than white lead. It is true, it does not spread so well, under the brush, but that is remedied by charging the brush oftener, or giving the surface an extra coat, etc. etc.

In 1808, and up to about 1860, the drawbacks of white lead were, in fact, considerable, but since then, and more especially at the present time, white lead is enormously altered, both in its manufacture and its use, which has during the polemics of the campaigns, undertaken against this pigment, enabled the argument to be reversed, so as to read, that the defects of white lead are so unimportant, compared with the drawbacks of white zinc, that one cannot rationally condemn the former to bestow all preference on the latter.

However that may be, this report of Fourcroix, Berthollet, and Vauquelin was, at the time, as Stas in 1855 says, in conformity with the facts enunciated by Courtois and Guyton de Morveau. It concluded, in the possibility of the substitution of white zinc for white lead, and in the hygienic benefits which would result. It enunciated, moreover, the principle agreed to by all painters, namely, that white zinc paint requires a bigger charge of paint and a greater number of coats. And then, as Stas says, "On examining more closely the facts which it contains, it was seen that the practical question was far from being entirely solved. Two essential elements were wanting to the solution of the problem—the cost price of white zinc, and the duration of the paint-work executed with this white; in one word, the economic aspect of the question."

Now, at the present time, it is likewise the economic side which remains, and will still remain for a long time, the sole argument, the sole reason, of the hostility of painters to the exclusive use of white zinc. It is the economic side in manufacturing and practical matters

which is the capital point, the important and dominant one. Roquette in 1842, and Mathieu in 1844, again drew the attention of the industrial and scientific world to zinc oxide and its use in painting, by making known the industrial processes of the manufacture of this body, but their efforts had no practical result. Towards this period, Gaultier de Claubry speaks, in the *Annales de Hygiene Publique*, of the advantages of the substitution of white zinc for white lead, and that is all, up to the famous campaign of Leclaire. He, at least, as a practical man, could put in practice the theory enunciated by Courtois and Guyton de Morveau, sixty years previously. The practical efficiency and the high authority of Leclaire, together with his great probity, must necessarily have imparted a gigantic impetus to the white zinc question, which up to then had remained almost wholly within the theoretical domain.

Let us hear what his contemporary, Stas, has once more to say: "When Leclaire communicated the result of his researches, he had already applied white zinc to more than 2000 houses or public buildings. It is certain that at this time an immense step was made. It was not a question of experiments on a small scale. In fact, the economical manufacture of white zinc had just been solved by the same Leclaire, aided by Barruel, by the discovery of a process of manufacture of white zinc, which enabled it to be supplied in competition against white lead ; a process which could be carried out without any appreciable inconvenience to the workmen. Discovering again a method by which white zinc paint can be rendered drying, without first rendering the

linseed oil drying by means of a lead compound (litharge boiled oil), finally, making known a whole series of yellow and green colours, harmless and permanent, replacing all similar colours, with a lead, copper, and arsenic basis, the economical reasons for stopping the use of zinc oxide no longer existed, and the reproach addressed to Guyton de Morveau, as to the defect of white zinc paint not drying quickly enough, fell to the ground after the discovery of the special drier (zumatic). Henceforth we possessed a perfectly harmless paint, of great whiteness and economy, as regards its mineral constituents. But it is to time to decide as to the comparative permanency, under all conditions under which it must be applied." At the time of Leclaire, the necessity for replacing white lead was doubted by no one. This pigment then committed undoubted and too well known ravages, and the substitution of another pigment, less actively injurious, was an evident requirement for the whole world.

"It was, so far, true," says the same author, on this point, that, when Leclaire announced, in 1848, that a practice of four years had demonstrated to him that zinc oxide, now termed white zinc, properly prepared and used, could replace white lead for all purposes, this discovery was received as a real blessing by all connected with public hygiene. The facts which Leclaire brought forward, in support of his assertions, appeared, in fact, so convincing, that everybody believed the question of the replacement of white lead was definitely solved. For a time even the illusion was such that every one seemed to agree in the futility of continuing researches, undertaken in all directions, for

improvements in the manufacture of white lead, so as to render it less unhealthy for the labourers.

"Some manufacturers went so far as to ask the legislative interdiction of the manufacture of white lead; and, what was astonishing, they succeeded in enlisting in this retrograde march the generality of white lead manufacturers through the medium of certain financial groups."

It will be seen from this remark, that the white lead manufacturers of that time, like those of the present day, cared more for their own particular interests than the interests of their industry. They also must discount the buying up of their factories under the form of a good government indemnity (compensation). What characterises Leclaire's campaign amongst all the others of the same kind, and even the last French campaign, 1900–1909, was the practical turn which it assumed from the beginning, the official results obtained, and the honours decerned, to this rich man, to this humanitarian, of the early days. In 1849 Leclaire obtained from the Société d' Encouragement, a gold medal as a proof of its gratitude for his works, as a whole. In 1850 he obtained, from the Institut, the grand prix Montyon, for his philanthropic acts.

The *first* decree interdicting white lead as the result of this campaign was issued on the 24th August 1849, by the Minister of Public Works. Afterwards, in February 1851, appeared the famous circular of De Presigny, the Minister of the Interior, Agriculture, and Commerce. This circular, so often quoted, so often appealed to, but almost always given in an incomplete manner, was printed with great wisdom. Appealing to the order of the Minister of Public Works, in 1849, and basing him-

self on a new report of the same minister, and adopting its conclusions, De Presigny says, especially, "In presence of these conclusions, Monsieur Le Prefet, I believe it right to ask you to take the necessary measures, so that white zinc may be used, generally, in paintwork to be executed in departmental buildings.

"*An exclusive and absolute prescription would risk creating too sudden a disturbance in the important manufacture of white lead, but it is essential, at least, that comparative trials of both paints be made on a large scale, in such a way that preference be irrevocably given to that one of the two in which experiment shows superiority from the double point of view, sanitary and economic.*"

That is not all the circular, but it is the essential part, the only executive one treating the question legislatively. All the part put in italics by the Author should still be meditated on, for it is a real administrative pearl, a true model of ministerial judgment.

After what has been already seen in this history, of efforts made for seventy years, by grand men of science, by great philanthropists, and by public authorities, in favour of white zinc, it might be believed that white lead was finally dethroned from its supremacy in paintwork. However, it was nothing of the kind. Public authorities brought the best of will to bear, but whatever their intentions, they did not agree to go so far as to suppress white lead by legislative enactment. They recoiled before the consequences. They were restrained by certain considerations, contained in the reports themselves, from which they justified their decrees against the pernicious white. It must be well recognised, in

fact, that in all the consultations demanded there was, alongside praises of white zinc, *restrictions* which had to be taken into account, which could not be overlooked.

The report of 1786 to the Minister of Marine says that the white zinc paint used on the *Languedoc* took six days to dry, and that white lead only took four days. *Hence, less drying.*

The report of Fourcroix, Berthollet, and Vauquelin, of 1808, stated, that white zinc spread less satisfactorily; that is to say, that it yields less than white lead, not supplying so much under the brush, that an extra coat must be given, therefore *covering less, and thus justifying the critical complaints of practical painters.*

After Leclaire's campaign, however, and in spite of the Presigny Circular, which in itself is very restrictive or very prudent—after Leclaire's campaign, we repeat, the Government seems, at last, to have decided to solve the problem more radically than by decrees or regulations. In 1853 a Commission, consisting of members of the Committee of Arts and Manufactures, and of the Committee of Public Health, were specially charged to investigate whether there was occasion to prohibit, in an absolute manner, not only the use for all paintwork, but even the manufacture, of white lead. It has been already seen that the generality of white lead manufacturers were enlisted into a retrograde step of this nature, but that this retrograde step was rather the result of certain financial combinations than the act of well-formed opinion.

The Government might believe, with more conviction than calculation, and in face of such a unanimous

manifestation, it was its duty to submit the question of the total and radical suppression of white lead to official scientific authorities, the more so as it was solicited by those to whom it was their own vested industry. Now, the Government Commission, although declaring itself persuaded that the substitution of white zinc for white lead was in course of being brought about, naturally, that Commission, however, did not dare to propose the radical interdiction of the latter, either in its use or in its manufacture, and it came to the following conclusions:

"1. There is no occasion to interdict the manufacture of white lead, the improvements introduced into this manufacture having removed from it in an almost complete manner, its unhealthiness and its dangers. But it is important that the Administration take efficient measures to ensure that these improvements be adopted in all factories, and that the latter be subject to special inspection.

"2. There is no occasion to interdict the use of white lead in paintwork, for certain precautions up to a certain point can protect the workmen from lead dusts; and, moreover, for this particular purpose, the substitution of white zinc for white lead tends to operate naturally. The support of the Government, and the differences of the [French] duties levied on lead and on zinc, are in favour of that change, without a violent disturbance, and without attacking the freedom of commerce.[1]

"3. The interdiction of the manufacture and use of white lead, in the arts and in industry, would have,

[1] This was in 1853. These duties have varied much since.

moreover, the drawback of creating very great difficulties, from a financial and legal point of view."

In face of such restrictive conclusions, the Government could not propose the interdiction of white lead, and the project dropped. And what happened? Far from taking place, naturally, by itself alone, the substitution of white zinc for white lead did not take place at all; white lead continued to be used, and in spite of Decrees, Circulars, Regulations, it rapidly regained the supremacy, which it preserved, whilst developing, even to a greater extent, during the whole period of half a century up to the new and lengthy campaign commenced in 1900, which did not end until nine years later. After famous debates, numerous inquiries, and counter-inquiries, and ardent polemical controversy, alterations of text, recommittals, and delays of all sorts, it only ended by the agreement come to between the Chamber and the Senate, to end it in good time; an agreement which enabled the passing of the [French] Act, which we all know, forbidding [in France] the use of white lead in house-painting; the manufacture and the sale of white lead in all its forms, dry white lead, and stiff white lead paint remaining intact.

We might stop here, the course of our history, already complete, although very rapid, the last campaign is still too near us, and we would plead the need of abstaining from any judgment on it; but, if we do not wish to judge this campaign in any way—a campaign in which the Author, moreover, was greatly concerned—nothing hinders us from relating the salient facts, and from following its evolution as an impartial historian. The history of white

zinc, as has been said in the beginning of this book, is very chequered; it is, therefore, interesting for painters to know, up to the finish, the stages through which it has passed.

If the campaign against white lead, conducted by Leclaire, sixty years before that of 1900–1909, was characterised by its practical, strictly trade character, the last campaign, which finally brought about the suppression of this cursed white lead, which had actually a hard struggle, this last campaign may be characterised as of a hygienic nature, for it was especially from the public hygiene point of view that the position was taken up. Those who spoke, who engaged in the struggle, continued it, and finished it, were above all hygienists. Although bursting out very suddenly, very soon after the Universal Exhibition of 1900, the new campaign in favour of white zinc had had, previous thereto, certain preliminaries. As far back as 1875 Dr. Layet published his *Traité sur l'Hygiène et la Pathologie Professionnelle des Industries.* Some time afterwards, Dr. Napias wrote and published his *Manuel d'Hygiène Professionnelle*, where there is to be found, on the subject of painters and painting with white lead, the famous phrase, so much exaggerated and for which he was so much blamed, declaring that Routine (rule of thumb) alone is opposed to the exclusive adoption of white zinc, and to the complete abandonment of white lead. He accused this routine of *sending to their death, every year, hundreds of workmen and of maiming thousands.* In 1879–1880 Paillard—architect of the Prefecture of Police [Seine]—made a communication to the Society of Public Medicine

and Professional Hygiene [of Paris], based on the annual statistics, showing a great number of cases of lead colic. As a sequel to this communication there was a memorable discussion at the society, in which Dr. Napias replied to President Boulay, architect, who energetically demanded the suppression of white lead by legislation.

"We do not demand," said Dr. Napias, "that the law intervene here; it is for instruction alone to enlighten the masses. We desire that the workmen be instructed as to the danger which threatens them. We desire that architects ally themselves with the hygienists in this good work, and that they exact from their contractors the exclusive use of white zinc. We desire, also, that ministers, towns, parishes, administrations, specify, in the case of works they are about to undertake, that the basis of the paint be white zinc."

Napias also expressed a restrictive opinion as to the application, but he did not go so far, in spite of his intimate conviction, as the radical and absolute interdiction, by a law, for the suppression of white lead. In 1881, Dr. Armand Gauthier, who from 1872 was entrusted with the Annual Reports to the Prefecture of the Seine, on Lead Poisoning in Trades Utilising Lead and its Derivatives, author of the official statistics, published every three years, on this special subject, presented to the Conseil d'Hygiène et de Salubrité a report on the risks which white lead and red lead caused the workmen engaged in manufacturing or handling these dangerous products to run. He asked at the same time that a Commission should be nominated

to elaborate regulations in factories, workshops, and sheds, where the manufacture and handling of lead and its derivatives are carried on. The Commission was nominated. It elaborated a whole programme of instructions and precautions, which "was adopted by the Council in its session of 23rd December," 1881. As regards paint, the following are the prescriptions of the Conseil d'Hygiène et de Salubrité :

"Workshops and sheds must be well ventilated and widely open, everywhere where dust may arise, from grinding, rubbing down, and burning of paints and plumbiferous paints. The apertures should be left wide open on every occasion that white lead paints are applied on walls and furniture, so long as they are not dry. Sifting or sieving, shifting, mixing of paints should not be done in the spot where the workmen usually stay. All the parts of the workshop must be washed (swilled) with water each time that poisonous dust arises and is deposited on the walls, the woodwork, and the furniture. The master painter, or in his absence the foreman of the workshop, is held responsible for seeing that these precautions are observed, and of satisfying himself that the workmen before going to take their meals put off their working blouses and wash themselves. Hand-grinding of dry white lead can only be entirely disapproved of, and its admixture with oil by means of the muller. This practice is the cause of a great number of cases of poisoning. It is much preferable, in order to mix white lead with different pigments, to take that which has been previously mixed with oil in factories."

This regulation, proposed by the Conseil d'Hygiène in

1883, was the subject of a special Order by the Prefect of the Seine, and Dr. A. Gauthier, in his evidence before the Parliamentary Commission of 1902, declared that this measure almost immediately produced good results. The number of patients, which was 600 per annum in 1878 to 1883, fell to 150 in the triennial period following. This latter figure kept so for some time; then, owing to negligence, relaxation, in the observation of the restrictions of the Order, it rose to 200 per annum. In a fresh report to the Conseil d'Hygiène, recalling the good effect of the restrictions when they were observed, Dr. A. Gauthier required of the inspectors still more active supervision, and again the number of patients fell to 130 or 150 per annum; and, moreover, adds the reporter, they were generally slight cases, which did not exceed more than from twelve to fifteen days in the hospital, and that on a population of 30,000 to 32,000 workmen, at a minimum, who handle lead in Paris under all its forms. In spite of this small proportion of patients and the slightness of their illnesses, it was still too evident that lead poisoning required to be fought seriously; and Dr. A. Gauthier, recognising that it was painters who occupied the prominent place amongst those poisoned, wrote in a later report, "Whence comes this recrudescence of patients amongst painters?" "From negligence in the means of preservation, which however remain for them a question of life or death." But he did not exaggerate the danger; he even opposed during the campaign and very vigorously the exaggerations which could not fail to be made, and he was blamed therefor not less vigorously; nevertheless, it was he who first sounded the

alarm on several occasions. They were his statistics which were invoked, but he wished also to bring back to sound appreciation of facts those who wandered away into exaggerations, the consequence of which was to alarm public opinion uselessly, and to aggrandise a risk, which he said was considerably reduced, in its frequency and in its gravity, since painters ceased to grind white lead, which they received in the form of stiff white paint, directly from the factories. However, the risk was undeniable, and, although reduced, hygienists wished and felt constrained to reduce it further, if not suppress it altogether.

In 1891 the Commission des Logements Insalubres de la Ville de Paris, in its session of 27th April, adopted, unanimously, a report presented to it by M. Finance, then Sub-Director of Work, a former painter that the Author knows personally and holds in great esteem, as much for his straightforwardness as for his unwearying efforts towards the moral, intellectual, and professional improvement of the working classes. His profound conviction of the superiority of white zinc was known to the Author for a long time prior to the campaign against white lead, and although the Author does not share this conviction in such a wholesale manner, he heartily acknowledges the sincerity of that of M. Finance.

With a humanitarian object, which does him credit, he proposed to the Commission des Logements Insalubres (with which at that time he was freshly connected) the following conclusions, which were unanimously adopted :

"The Commission, taking into consideration at the same time both the healthiness of dwellings and the

health of the workmen, and the interest of the proprietors, and considering that in paintwork it can choose between two substances, the one almost harmless, the other constituting a violent poison, has adopted the two following propositions :

"1. The use of white zinc, to the exclusion of white lead, shall be specified in all paintwork.

"2. The Commission renews the resolution, which it passed in 1880, as to the exclusion of white lead in public works."

A platonic resolution, alas, since recalled to mind, ten years after it was first passed ; it had not then had perceptible results, and during a fresh period of ten years was almost forgotten by the authorities, until the campaign commenced in 1900 to 1901, which, in spite of its vigour, was destined to last for an equal period of time, as it did not terminate until after nine and a half years of unceasing efforts.

This campaign, the most energetic that was ever conducted, was begun, first of all, by some short newspaper articles, then came into better shape by lectures from eminent and official medical men.

1. Dr. Bremond, the 26th November 1900, at the Musée Social, where he exclaimed, "Let the Corporation of Painters assemble, let it decide out of respect for human life to interdict, absolutely, every one of its members from handling white lead, and master painters will be forced to give up the paint that kills. This strike, declared in the name of hygiene, is bound to close two or three factories, in which the rats, themselves, are not safe, and where Professor Grisolle desired to send convicts."

The virulence of this apostrophe, which sounds like an appeal, toned by a sort of threat, caused it to be foreseen that the campaign against white lead was to be conducted vigorously and resolutely.

2. Professor (Dr.) Laborde, the 13th January 1901, in the grand amphitheatre of the [Paris] School of Medicine, who gave, in his long developments, the history of lead poisoning, showed its causes, determined its effects and its consequences, and who terminated by this energetic peroration: "Is there a remedy for this implacable evil, preventive, palliative, or curative? I boldly reply, formally, NO, three times No! Or, rather, there is only one—the inevitable radical remedy: condemnation, without appeal; prohibition of the poison, as a measure of public and industrial health."

3. Professor (Dr.) Brouardel, 17th November 1904, at the (Grand Orient de France). This lecture was not, perhaps, so brilliant in its oratorical periods as previous ones, but it was substantial. One there listened to a real lesson on lead poisoning, from a scientific and erudite man. Brouardel was not a polemist; he was, above all, a professor, and it was as a professor that he talked, but the authority of his name guaranteed in itself, alone, the great interest of the cause for which he spoke.

4. Dr. Mosny, 4th November 1906, in the large hall of the Trocadero. The most important lecture, from the point of view of the number of auditors and the rank of the scientific personages who surrounded the lecturer, all professors and doctors of renown. From the point of view of the lecture itself, it was once more the white

ad process, and the history of lead poisoning, with in ldition the process of statistics.

But, between the dates of these large conferences, her facts inherent to the campaign occurred. Official nd officious Commissions were nominated, reports were eposited, resolutions were passed, and at all these the uthor must cast his glance as a historian.

In the beginning of 1901 the Minister of Public Works ldressed a circular to the Chief Engineers of Roads and ridges, of all Departments, and to those on special duty. here reached the Minister 113 reports, 107 decided nswers; of these 107 answers, 73 were entirely favour-ble to the exclusive use of white zinc, and 32 only unctioned it for interior use, preserving white lead for ne exterior, because they said the durability of the tter is greater. Finally, two reports were decidedly nfavourable to white zinc, as dearer and less durable. Ioreover, 38 replies, amongst those which were favour-ble to white zinc, foresaw greater expense in the work, hether owing to the necessity of giving four coats in-tead of three, to cover properly, or the necessity for more equent renewal of the paint with a zinc basis; 10 eplies declared quite the contrary as to the cost price, nd 18 as to the covering capacity. It will be seen that ne opinions were very much divided.

Almost at the same time, on the initiative of the 'resident du Conseil (Minister de l'Interieur), the Conseil eneral des Batiments Civils took up the question, and, on ne report of M. Moyaux, inspector-general, the Conseil assed the following resolution:

"Whereas, first of all, the risk incidental to the use

of white lead is due very greatly to the imprudence and want of precaution of the workmen :

"Whereas, on the other hand, white zinc is, in indoor paintwork, as durable as white lead and of a finer colour, and that it is as easily applied by the workman who has become accustomed to it:

"Whereas it is important to remark, however, that it would appear to result, from trials made, that it does not withstand the weather so well in outdoor work as white lead, and requires to be renewed more frequently:

"Whereas, on the other hand, its cost price may be regarded as equivalent to the cost price of white lead, as follows from the note annexed hereto, but the expense of upkeep will be greater in outdoor paintwork, owing to the more frequent renewal just mentioned :—

"Now therefore, and in conformity with the conclusions of the reporter—

"It is resolved—

"That white zinc may be substituted for white lead, without compromising the durability of indoor paintwork, without injuring its appearance, and without increasing its cost.

"But, as regards outdoor paintwork, that the duration thereof would be less."

This resolution contains restrictions, identical with those contained in the reports of the scientific bodies, given previously in Leclaire's campaign.[1]

[1] AUTHOR'S NOTE.—At the moment of the deposit of this report the respective prices of the two paints differed only by 8 to 10 francs the 100 kilos, 3s. 2d. to 4s. the cwt., but after the passing of the Act the price of zinc oxide rose, and at the date of the publication of [the

Le Comité Consultatif d'Hygiène Publique was also consulted, but it could only go into the matter from a hygienic point of view, not having the desirable technical skill. It pronounced itself, and could not do otherwise than pronounce itself greatly in favour of the substitution of white lead by white zinc, and moreover, from a hygienic point of view, this substitution is not doubted by any one. If that were the only point at which to look, the solution of the problem would have been solved by the general unanimity of theoretical and practical men long ago.

As confirmations to all these reports, resolutions, and conclusions, the different Ministers who had asked for them issued decrees interdicting in their respective departments the use of white lead; like those which were issued, sixty or eighty years before, they were not absolute. The Under-Secretary of Posts and Telegraphs enjoined the exclusive use of white zinc in all the spaces occupied by the staff, or intended for the installation of offices. *Hence prohibition for indoor work alone.*

The Minister of Commerce interdicted the use of white lead for all work to be executed in the grounds of the Minister of Commerce, of Industry, of Posts and Tele-

French edition of] this book in 1911 the price of the two products were as follows:

	Per cwt.	
White lead, 62 to 67 francs per 100 kilos	say, 25s. to 27s.	According to brands.
White zinc, 79 to 89 francs per 100 kilos	say, 31s. to 35s.	

And a further gradual and constant increase in the price of white zinc is expected!!!! [The Octroi duties of Paris render most goods dearer there than here.]

graphs, and in the spaces occupied by the services depending on the Minister.

The Minister of Public Works was more severe, but he granted permits to use white lead none the less.

"I have in consequence decided that in all work, done on account of my administration, it will henceforth be interdicted to make use of paints or *enduits* with a white lead basis.

"In all exceptional cases, where the engineers believe it indispensable to resort to the use of white lead, they will have to provide themselves with a special authorisation from the superior administration."

Up to now, white lead was only partially condemned. It was recognised, almost by everybody, as necessary for outdoor work, and even with the parliamentary action which was to follow, the condemnation did not go further than to be demanded, in three consecutive schemes, for indoor work alone. The radical interdiction of white lead was not decided on, until the very last, as a sort of compromise, as will be seen later on.

The parliamentary action, in July 1901, began by a question as to the measures which the Government contemplated to suppress white lead in public works. Owing to the nearness of the holidays, this question did not come up for discussion until February 1902. Its object was, first of all, to develop the question which was asked the Government seven years previously, afterwards to get explanations as to the violation of the preceding ministerial decrees—violations shown by the important contracts for the supply of white lead, entered into on account of certain ministries. It was even asserted

that certain administrations, in spite of the decrees of their ministers, continued to use white lead by simply calling it white zinc.

The question was developed by three deputies in succession, and at great length, to whom the Minister of Commerce replied:

"The question of law, which consists in discussing what should be the limits of a decree issued in regard to white lead, has not been raised, nor do I intend to raise it. I simply recall to mind that the rights of the Executive Government are, in this matter, very extensive, that the Court of Cassation has recognised on several occasions the right of the municipal authority to prohibit the use of certain materials, and that, in execution of the Act of 19th July 1845, on the sale of poisonous substances, an order of 1846 was issued, absolutely forbidding the use of arsenic and its compounds for certain determined uses. I will not draw from these facts the conclusion which it would be easy to deduce therefrom, and here is the reason: it is, that the question is now under examination; it is, that the Act of 1893 prescribes that the Minister of Commerce is not to issue, in this matter, a regulation of the public administration, except after the advice of the Consultative Committee of Arts and Manufactures and the Council of State. I have sent the scheme of the decree of the Commission of Industrial Hygiene before the Consultative Committee. It will afterwards go before the Council of State. I do not intend by that in any way to diminish the responsibility of the Minister, who will finally have to come to a decision. I simply wish, in conclusion, to assure the Chamber that,

when the time comes for a decision to be taken, all the interests involved will be taken into account, in the front rank of which is the public health."

The Chamber, as a consequence of this discussion, passed the following order of the day:

"The Chamber, relying on the Government to issue, in conformity with the Act of 12th June 1893, concerning the hygiene and the safety of workmen, a public administration regulation regarding the use of white lead in paintwork, passes to the order of the day."

As will be seen, it was not a question, up to now, of any prohibitive enactment, but a regulation by ministerial decree. The deposit of a draft Act, interdicting the use of lead, was not decided on until after the non-acceptation, by the Committee of Arts and Manufactures, of the complete interdiction of white lead, as well as by the objections of a legal nature raised by the Council of State, which declared that prohibition clauses, in a public administration regulation, were not authorised by the terms of the Act of 12th June 1893, on the hygiene and safety of workers in industrial establishments.

Whilst awaiting the drafting of an Act, the Minister of Commerce issued a decree, the chief draft of which was supplied by the Commission of Industrial Hygiene, but which the Consultative Committee of Arts and Manufactures had almost completely transformed, only prohibiting dry white lead and authorising the use of stiff white lead paint; interdicting also dry rubbing and pumicing of white lead paints. The decree of the public administration, issued in conformity with the views of the Committee of Arts and Manufactures, and freed from any clause of

nterdiction, contained five articles. It was pro- l the 18th July 1902, and copied in part by all rs which have regulated the use of white lead. st article bore, that white lead could not be used s stiff paint. The second article interdicted using with a white lead basis directly in the hand that cted against the *enduiseurs*, Paris specialists, who ays had the deadly, but very practical, habit of e *enduit* in the hand, in the palm itself, to place knife, clean it, and wipe it as required. Article cted dry working with the scraper, and dry with glass paper of white lead paints. Article bed that for wet rubbing down and pumicing, rally in all painting operations with white lead, oyers should supply the workmen with blouses ls, to be used exclusively for this work, on the ich they had to insist, keep in good repair, and uently.

escription had some results which the Minister, nittee of Arts and Manufactures, as well as the f the State, were far from expecting. Certain painters of Paris supplied their workmen with the drôle cut of which, or the *very prominent* used them to be rejected at the very outset by who would never consent to wrap themselves ich grotesque garments. Certain workmen, n the terms of this Section 4, claimed washing r their own blouses from their masters. Some ave it; that, at any rate, saved them the cost of Other masters refused it, replying to their men, the firm's blouses."

"Never in our life," replied the painters. "We are not guisers, and, moreover, we do not wish to be branded, or numbered, like railway rolling stock, or like convicts."

The trade guild (Le Tribunal des Prud' Hommes) took up the matter on several occasions, and condemned several refractory master painters to a fine for washing, that created a great stir; then this jurisprudence was no longer allowed. It was, in any case, very funny and very questionable.

Finally, Article 5 ordered the affixing of the text of this decree, by the heads of firms, in the places where the men were taken on and paid off.

This decree, the very wise prescriptions of which are found in almost all foreign regulations, fell to the ground, and was repealed by the Act of 1900, the first draft of which was deposited by a new office holder of the Ministry of Commerce, 1902.

The first draft of the Act against white lead bore on it interdiction, within a year of its promulgation, of the use of white lead and of litharge boiled linseed oil (plumbiferous oil) in all priming, filling up, and *enduisage* work—work regarded as presenting the greatest risk of lead poisoning. In addition to this declaration, white lead was to be completely prohibited for indoor work, three years after the promulgation of the Act; and, moreover, a public administration regulation, issued after consultation with the Consultative Committee of Arts and Manufactures, and the Commission of Industrial Hygiene, could extend this interdiction to outdoor paint-work.

There was left, on the other hand, to the Minister of

Commerce, the power to authorise, exceptionally, for certain works, the use of white lead and other lead compounds, after consultation with the Committee of Arts and Manufactures in each particular case.

The draft of the Act was sent to a Commission, nominated in the bureaux of the Chamber, on the 25th November, which was constituted the 26th, and sent in its report on the 28th of the same month. It was a fine example of parliamentary speed, which Budget Commissions might take to heart, so as to avoid twelve provisional conditions. The reporter might have said, that they had done the work quickly. Moreover, he himself agrees, since, in his supplementary report, he says that in face of the protests which flowed in from all quarters, in the interest even of the draft of the Act, it was not possible to eliminate forthwith all the objections; and the Commission unanimously agreed, contrary to their first decision, not to ask its report to be placed on an immediate order of the day, so as to be able to make a searching inquiry and hear interested parties. Six months afterwards, the new report was submitted, and was discussed before the Chamber a month later, the 30th June 1903. And, after some rejections of amendments, the whole of the Act was passed unanimously. The Senate took it up, on the 22nd October following, and a Commission was nominated on the 12th November. The latter was not, by any manner of means, as active as the Chamber's Commission, since the first report to the Senate was not sent in until April 1905, say seventeen months afterwards, three times longer than the reporter of the House of Deputies. But it must be remarked, that the

Senatorial reporter undertook a colossal work, devoting himself to the task of a Benedictine, making minute inquiries throughout the whole of France, elaborating gigantic statistics, controlling other inquiries, collecting documents in enormous quantities, and contesting with figures in support thereof, the greater part of the documents, and the statistics of the report of the Chamber. This report, in which figures abound, or synoptic tables in considerable number, has this peculiarity, and that is, that the reporter does not speak except in a very restrained measure, but he does so throughout with such biting irony, that his remarks are like so many blows from the tusk of a wild boar, which would seem to overwhelm his opponent. The conflict is fierce; the battle will be hot between the two Assemblies, for neither of them will wish to budge a foot. Each will try to maintain its views, to defend its reporter. It was not so, however; the reporter of the Senate having to be re-elected before the distribution of his report, did not offer himself for re-election, thus losing his position as Senator. He was replaced on the Commission, both as a member and as reporter. Another report was made, and as the Commission had differed in its views, up to then opposed to the interdiction of white lead, it charged the new reporter to report against the conclusions, which it had previously adopted and by which it had decided to wait, before reporting definitely, the result of the researches of the Commission instituted at the Ministry of Commerce, for the purpose of examining the comparative value of the different products used in painting. It also thought that it was necessary to know what would be the result of the new medical inquiry

ordered by the Minister of Commerce, and to know likewise the resolutions, from the examination of the draft of the Act on Trade Diseases. In the meantime, they advised to reconstruct, in a liberal sense, the decree of the 18th July 1902. The Commission also thought that, after having consulted real practical men, and taking into account the arrangements in force abroad, especially in Germany, it would be easy to make a practical and efficient regulation for the use of all lead compounds, which would be accepted both by workmen and their masters. After the renewal of the Senatorial elections, the Commission resumed the discussion of the conclusions of its former reporter, and, as we have seen, it nominated a new one; then after some discussion it accepted the draft of the Act passed by the Chamber, but modifying Article 3, and adding thereto the principle of compensation to be granted to manufacturers whose industry would be abolished. Article 4 was reconstructed, and the Minister of Commerce was deprived of the power of granting exceptions after consultation in each case with the Committee of Arts and Manufactures and the Commission of Industrial Hygiene. The reconstruction consisted in simplifying, for the requirements of tradesmen, all those formalities which would have taken up too much time. The Senatorial Commission proposed the following simplified text: "A public administration regulation will point out the special works, for which an exception may be made to the preceding regulations." The new reporter asked this time for the interdiction of white lead indoors, at first, on account of public health; it will be, he said, a commencement in rendering the industrial domain wholesome. The

discussion did not open in the Senate until the 22nd November, 1906, or rather it was begun on that day, but it was continued on the 23rd, the 27th, the 29th, and the 30th November, and the 4th December. The presentation of a counter-draft prescribing the regulation of the use of lead paints, instead of their interdiction, was opposed energetically by the Minister of Labour, by several Senators, by a Government Commissary, by the reporter, and was finally rejected. The principle of compensation proposed and supported by the Commission was opposed by the Minister of Labour, but supported by several members, and was adopted, in spite of the above-mentioned ministerial intervention, and that of the Minister of Finance. The Act passed by the Chamber was thus profoundly altered, even transformed by the new text of the Senate. The use of white lead was not interdicted, except in indoor work and after an interval of three years. For outdoor work, the Senate reserved the question entirely, hence absolute liberty to use white lead in this case. Finally, the principle of compensation for expropriation to manufacturers was granted. This new text had to come back to the Chamber, which in its turn modified the text of the Senate by suppressing the use of dry white lead in painting, and the principle of compensation to manufacturers, attacked in their industry—a principle which it forcibly refused to admit, and this third draft of the Act took in its turn the road to the Senate. It did not issue from it except profoundly altered, and even disfigured, since the final Act precisely includes the clause which had been contested, and annuls that which had been the most supported—interdiction of the use of white

lead indoors and outdoors on all paintwork, that is total prohibition, which, however, neither the Chamber nor the Senate originally desired—refusal of all compensation, of which the Senate had maintained the principle, and made a condition *sine qua non* of its acceptation of the Act passed by the Chamber. The delay in the enforcement of this Act was extended to five years after its promulgation, so that it does not become law until the 20th July 1914. Neither the first draft of the Chamber, nor of the Senate, nor the second draft of the Chamber, were definitely passed. It was a transitory draft which was carried, and it required an ultra-parliamentary understanding between the two Commissions to come to a final agreement of which the Act of the 20th July 1909 is the result. Henceforth irrevocable, and if it may be criticised, as regards the gaps and inaccuracies which it contains, yet it possesses at least the advantage of not subjecting painters to the arbitrary and vexatious annoyances incidental to all official regulation of an industrial product.

CHAPTER XI

LEGISLATION

FRENCH ACT OF 20TH JULY 1909, INTERDICTING THE USE OF WHITE LEAD IN ALL PAINTWORK ON BUILDINGS

SECTION I.—In workshops, yards, buildings in course of construction, or repair, and generally in every place of work where house-painting is being done, the head of the firm, directors, or managers must, notwithstanding the measures prescribed, in terms of the Act of 12th June 1893, conform with the following requirements:

SECTION II.—At the expiration of the fifth year following the promulgation of the present Act, the use of white lead, plumbiferous linseed oil [lead boiled linseed oil], and any product containing white lead, will be interdicted in all paintwork, of whatever nature, executed by working painters, both as regards the exterior and the interior of buildings.

SECTION III.—A public administration regulation, after consultation with the Consultative Committee of Arts and Manufactures, and the Commission of Industrial Hygiene, will indicate, if need be, the special works for which exemption from the preceding requirements may be allowed.

SECTION IV.—The carrying out of the provisions of the present Act will devolve on the factory inspectors. For that purpose they will have the right to enter into all the establishments specified in Section I. However, in cases where painting is being done in dwellings, the inspector cannot enter into such places until after having been authorised by the persons occupying such dwellings.

SECTION V.—Sections V, VII, paragraphs 1, 3, 9, 12 of the Act of 12 June 1893, are applicable to the determination of the contraventions contemplated by the present Act, as well as their repression.

The present Act, discussed and adopted by the Senate and by the Chamber of Deputies, shall be enforced as a law of the State.[1]

Public Administration Regulation[2]

Although Section III of the Act, given opposite, includes the publication of a public administration regulation, which in the ordinary course of business was bound to appear within six months of the promulgation of the Act, this regulation has not yet appeared, nor even been elaborated ; it will hardly appear before the year 1914, the epoch assigned for enforcing the Act interdicting the

[1] TRANSLATOR'S NOTE.—There seems nothing in this Act to prevent the application of white lead paint either in or out of doors, with a paint spraying machine, neither is lead boiled poppy-seed oil, nor lead boiled menhaden oil, etc. etc., forbidden, and, *mirabile dictu*, the more poisonous red lead can be freely used without any restriction whatever, except as a drier in boiled linseed oil !

[2] Corresponding to our Order in Council, but not apparently laid before Parliament.

use of white lead. That was at least the answer which was made, in a high place, to the Author's request for information.

It is therefore impossible for the Author to place this document before his readers. He had hoped thereby to complete the information contained in this *Manual.* He regrets all the more not being able to fill up this gap, which, being bound to treat more especially of exemptions and of permits against the enforcement of the law, it would be well to know the requirements beforehand.

Foreign Legislation and Regulations

Belgium—Germany—Switzerland—Austria

It will not be uninteresting, the Author believes, to give in this treatise on white zinc the legislation and regulations actually in force in the different European countries engaged in the eventual substitution by this product of the use of white lead, of which France alone has declared the radical and absolute interdiction. The French Act, however, makes reservations, in Section III, on the subject of certain permits, to use white lead, which may be granted in spite of this suppression, *if need be*, for special work.

By comparing the texts, the reader will be convinced of the extreme difficulty of the regulations, because almost all are diffuse, fastidious, often bombastic, and always annoying in one or other of their requirements, which does not prevent them all from being indiscriminately of highly problematical application. The Author who has opposed

in France the suppression of white lead does not hesitate to recognise that a country, which desires to protect itself against the white lead poisoning of painters *when it believes there is a serious or inevitable danger*, will not do any good, by mere regulation, however minutely it may enter into details. There is too much rubbing up of dignity the wrong way, too many vexations and restrictions to be submitted to, for all the requirements of the regulations to be ever applied and supported by the painter ; the only measure that such a country can take, to be logical with its conviction, is to suppress totally the injurious product, the consequences of the use of which it dreads.

BELGIAN REGULATIONS

In December 1903, a draft Act, almost based on the draft of the French Act, was laid before the Belgian Chamber of Representatives, by Dr. Delbasté and six of his Socialist colleagues. The Belgian Government did not wish to entertain the subject of the interdiction of white lead, and refused to entertain the scheme presented for the purpose. Eighteen months later, in May 1905, Delbasté resubmitted his scheme, to which the Government replied three days afterwards, by the publication of a Royal Warrant which had just been signed a few days previously. In the explanation of the reasons for this Warrant the Minister of Commerce and Industry gave the reasons why the Belgian Government preferred the regulation to the interdiction of white lead.

In the first place, the Belgian Section of the International

Association for the legal protection of workmen had refused to take this radical measure into consideration.[1]

Secondly, the Minister recalled that the results of comparative experiments which had just been made in France, to ascertain whether white lead could be replaced under all conditions by white zinc would not be known for several years. The Belgian regulations, apparently inspired by the French decree of the Minister of Commerce and Industry, 18th July 1902, differs therefrom by the partition of the measures to be taken. Some are imposed on the master painters or foremen, the others on the workmen. The following are the requirements and measures of the first Royal Warrant, signed on the 13th May 1905, which was superseded in 1910 by a Royal Warrant which is given after the former, purely as a matter of reference:

The First Belgian Royal Warrant Regulating the Use of White Lead

Having read the Act passed on the 2nd July 1909, relating to the health and the safety of the workmen engaged in industrial and commercial operations; and

Whereas there is reason to prescribe measures, with the object in view of preventing the risks which the use of white lead entails in house-painting;

Having read the advice given by the expert sections

[1] It is a curious thing, that the French Section of this same Association had approved of the suppression of white lead, whilst the Italian and the Swiss Sections decided respectively for regulation and for a trial of suppression.

of the Councils of Industry and Labour, and by the permanent deputations of provincial Councils;

Having read the opinion of the Superior Council of Industry and Labour, we have ordered, and it is hereby ordered, as follows:

SECTION 1. In house-painting the mixing, grinding, handling, and use of white lead, as well as the rubbing down and pumicing of surfaces painted with white lead, are subject to the undernoted restrictions:—

Measures Imposed on Master Painter and Foremen

SECTION 2. Master painters and foremen possessing an equipment for mixing white lead will be required to advise the factory inspector, in writing, of the spot where it is at work. This advice must be sent within the three months following the date of the promulgation of the present Warrant, if the equipment is already at work at that date; and in other cases previous to the use of the said equipment.

SECTION 3. The mixing of white lead must be carried on in such a way that the workmen do not come in contact with the dust resulting from the operation.

SECTION 4. The conveyance of dry white lead must be effected in closed vessels; its transference from such vessels must be effected slowly, and with the necessary precautions, to avoid dust. The soil [floor] of the spots where this work is done must be frequently sprinkled with water.

SECTION 5. Grinding and all other manipulations, whether of dry white lead or mixed white lead, or of any other

compound containing white lead, must be carried on in such a way as to prevent contact of the material with the hands as well as the production of splashes.

The master painter or foreman must place the articles required for this purpose at the disposal of the staff.

SECTION 6. Master painters, foremen, or their delegates must take care that the tools and equipment generally are kept in good working order.

SECTION 7. It is forbidden to rub down and pumice dry surfaces painted with white lead. Surfaces freshly coated with *enduit* as well as mouldings and grooves are excepted.

SECTION 8. Master painters, foremen, and their deputies must take care that the workmen, ordered to carry out the operations mentioned in Section 1 of this Warrant, wear a dress and a cap specially reserved for this class of work. The clothes, which the workmen strip off to work, must be kept away from poisonous dust.

SECTION 9. Master painters or their foremen will place at the disposal of their staff, both in their yards and in their workshops, water, the products required to rinse the mouth, to wash with soap the face and hands, and to wipe themselves. Master painters, foremen, or their deputies must take care that their staff perform the above operations before consuming food or drink, and before quitting the workshops or the working yards.

SECTION 10. Master painters or their foremen must cause the staff employed in the operations mentioned in Section 1 of the present Warrant to be examined quarterly by a doctor approved by the Minister of Industry and Labour.

The cost of such examinations, on a scale fixed by ministerial decree, must be borne by the master painter or foreman. The master painters or foreman must definitely remove from work which exposes to poisoning the workmen attacked by chronic lead poisoning and those who exhibit the recurring symptoms of acute poisoning. They must temporarily remove those whose general state of health is bad, at the date of the examination. They will keep a special register in conformity with the model delivered by the administration, and in which the approved factory doctor will register all the facts determined in the course of his examination. This register must be sent to the authorities each time a requisition is sent for it. Master painters or foremen must not employ workmen addicted to drink. They must forbid the introduction of distilled alcoholic liquids into workshops and working yards.

Measures Imposed on Workmen

SECTION 11. Workmen must not remove dry white lead until they have satisfied themselves that the vessels in which it is packed are tightly closed. They must empty out this material, with the precautions required to prevent dust.

SECTION 12. Those workmen, who have to handle dry white lead or white lead ground in oil, or under any other form, must do so in such a way as to avoid the substance coming into contact with the hands, as well as the production of splashes.

SECTION 13. Workmen are forbidden to rub down dry

surfaces painted with white lead. However, surfaces freshly coated with *enduit*, as well as mouldings and grooves, are excepted.

SECTION 14. Workmen ordered to carry out the operations mentioned in Section 1 of the present Warrant will wear a dress and a cap exclusively reserved for this work. They must keep them in good condition and clean, and must take them off before leaving the workshops and sheds.

Workmen must protect from poisonous dust the clothes which they strip off to work.

SECTION 15. Before consuming food or drink, and before quitting the workshops or yards, workmen must rinse out their mouths, as well as wash their hands with soap. Food introduced into the workshops, or carried on to the yards, must be enclosed in tightly closed boxes or coverings until meal-time.

SECTION 16. Workmen will keep the machinery and tools entrusted to them in good order.

SECTION 17. Workmen are forbidden to introduce and consume distilled alcohol liquors in the workshops or in the yards.

SECTION 18. Workmen must submit to the medical examinations provided for in Section 10 of the present Warrant.

SECTION 19. Factory inspectors and those delegated to the inspection of labour will see to the execution of the present Warrant.

SECTION 20. The determination and the repression of infringements of the requirements of the present Warrant will be carried out conformably to the Act of 5th May

1888, regarding the inspection of dangerous, unhealthy, or inconvenient establishments.

SECTION 21. The present Warrant will come into force three months after its promulgation.

SECTION 22. The execution of the present Warrant will devolve on our Minister of Industry and of Labour.

This Warrant was bound to be modified and remodelled afterwards, owing to the passing of the Act of 20th August 1909, forbidding the sale, conveyance, and use of dry white lead for paint purposes. Henceforth, painters not being able to receive white lead, except as stiff paint ground in oil, had nothing further to do with mixing nor grinding, and all the requirements of the regulations of the present Warrant concerning these operations fell to the ground; there was no further occasion for them. The Warrant of 13th May 1905 was therefore replaced by another Warrant, signed by the new King, the requirements of which are given below, *ne varietur*, both new and old, because they are the ones to be observed henceforth. They form, for Belgium, the definite regulation of this question, at least whilst waiting for the total suppression of white lead, which will certainly be demanded again, and which the master painters, for the most part partisans of white lead, as in France, will not oppose, preferring even this suppression to the regulation which has been imposed upon them by these Warrants, which they do not submit to, without a physical struggle, looking to the annoyances and the worry caused them at every step. The workmen, moreover, will not be vexed at being at last freed from the besetting and vexatious

obligation of medical inspection, against which they very often rise and protest by its non-observance, in spite of the opinion of the Court of Cassation, which does not acknowledge, like the tribunal of Verviers, that this obligation was an attack on individual liberty and dignity. In all morality, it is the tribunal Verviers which is in the right. The Superior Council of Public Hygiene, consulted on several occasions, gave its opinion in two reports, the one dated 1902, before the draft of the Act of Delbasté; the other in 1904, after the said draft was refused by the Belgian Government, which simply desired to regulate the use of white lead. Finally, in 1908, a long time after the Royal Warrant instituting the regulation given above, the Superior Council of Public Hygiene was consulted again by the Minister of Agriculture (? !) on the efficiency, from the point of view of the legal regulations, which interdicted (1) the dispatch of white lead intended for paint from factories where it is manufactured under any other form than stiff paint ground in oil, the conveyance, sale, and use of dry white lead for painting; (2) the dry rubbing down and pumicing of surfaces painted with white lead, any contraventions of which requirements would be punished with severe penalties.

The Council of Hygiene replied to the double question by the following report. The first of these requirements has not now the force which it had some time ago for working painters. It follows, from information that we have collected, that the greater number of them no longer mix and grind white lead in oil, this being done especially by the white lead corroder and the paint merchant. If some master painters still do so, it is scarcely in the hope

of making a profit. They know very well that the method of working is as uneconomical as dangerous. Some grind through habit, because they have always ground; others, because they fear adulteration, which appears to them more easily to hide in the paste than in the dry white lead. They buy the latter, and to control its purity they treat a portion with vinegar, which dissolves the plumbous compound and leaves the insoluble sulphate of baryta. There is no doubt that this class of painters would abandon grinding if they knew that it sufficed to extract the powder from the stiff paint by a little ether, and to wash the deposit repeatedly by this solvent, to test the residue as successfully as the powder itself which is delivered to them. Be that as it may, it will suffice to apply the requirements of the Royal Warrant of 13th May 1905, or to introduce therein a section forbidding painters to have in their workshops certain quantities of white lead, to undergo the process of grinding, on their premises. It is another affair, as regards the manufacturer or the large wholesale colour merchant. It seems to us very difficult to hinder a commercial man, even though he be not a manufacturer, from practising grinding, if he does so under good conditions. It appears to us that an interdiction of this class would result in securing to the white lead corroder a monopoly which would seriously increase the profits of his business, instead of causing or even allowing the manufacture of white lead to disappear. The law itself *would charge itself with assuring its prosperity and watching its development.* It would also be a rather uncommon spectacle for an administration to proceed to reinforce

an industry, which it must expropriate for reasons of public utility. The second requirement interdicts dry rubbing down and pumicing of surfaces painted with white lead. It would certainly from the point of view of the protection of the workmen have been of great efficiency. It is already inscribed in the regulation concerning the use of white lead in house-painting. In its report of 1904 the Council had expressed doubts on the possibility of applying it. The information collected since has only confirmed its fears on this point. Whether it be forbidden by Royal Warrant or by an Act, no serious result will be attained, and the Superior Council of Public Hygiene finally gives its exact replies to the question of the Minister :—

Requirement No. 1 has not the same interest to working painters which it had a few years ago; for reasons given above, its application presents certain dangers.

Requirement 2 does not appear to it realisable; the rigorous application of the rule concerning the use of white lead in house-painting would allow results to be obtained provided for by this requirement. The Council seizes this opportunity to recall its previous reports on the subject; it again expresses its desire to see the use of white lead interdicted in house-painting. It desires, whilst waiting this necessary solution, that the State Provincial and Communal Authorities completely suppress the use of white lead in all house-painting work which they carry on; this measure would develop the use of harmless substances, and thus pave the way for the general interdiction of white lead in painting, whilst immediately improving the hygienic condition of working painters. It desires that the regulation promulgated by Royal Warrant on the 13th May 1905, now reserved to matters of house-painting alone, be extended to every other kind of painting.

These desires of the Superior Council of Public Hygiene were only partially acceded to. At first, the Belgian Act did not interdict the use of white lead, because, as the reporter of the Senate, M. G. Dupret, says very wisely, *the legislature should not use the arm of interdiction but with the greatest reserve, and only in case of absolute necessity.*

But as regards dry white lead, M. Dupret again says, its use and its conveyance undoubtedly present grave dangers, and its interdiction should be pronounced. So the Act was adopted and passed in that sense, and Belgium painters can no longer use white lead in that form, nor even receive it on their premises, since the sale and the conveyance of it are interdicted for the uses of house-painting. It is true that dry white lead was no longer used by painters, and this interdiction caused them no annoyance. The sale and the conveyance of white lead, intended for other purposes than house-painting, has also been regulated by a special Warrant of 20th July 1910. The said Warrant bears in substance, that dry white lead, in powder or in lumps, can only be sold on the order of a purchaser authorised to use this product, the order given in writing, according to a form determined by the Minister, and attesting that this white lead will not be used in painting. As regards that which comes from abroad, it will remain consigned to the Customs until the consignee has received a transport permit, which he himself must ask for, in conformity with the requirements of the Warrant in question.

The Belgian Act of 20th August 1909, Regulating the Use of White Lead, which came into Force on the 20th August 1910

Section 1. The sale, conveyance, and use of dry white lead, in lumps or in cakes intended for painting, are interdicted. The sale, the conveyance, and the use of dry white lead, in lumps or in cakes, intended for other purposes, are only authorised under conditions and limits to be fixed by Royal Warrant.

Section 2. White lead, intended for painting, cannot be sold or conveyed, except as stiff white lead paint mixed and ground in oil.

Section 3. The partial or total interdiction of the sale, conveyance, and use of other dry products, in powder, in lumps, or in cakes, with a lead basis, used in paintwork

may be pronounced by Royal Warrant after consultation with the Superior Council of Public Hygiene.

SECTION 4. Dry rubbing down and pumicing of surfaces coated with white lead *enduits* are interdicted.

SECTION 5. Infringements of the present Act and the Warrants regarding its execution will be punished by a fine of 26 to 100 francs, say, £1 to £4.

SECTION 6. In case of a second conviction within the twelve months which follow a fine incurred in virtue of the present Act, the lowest penalty will be raised to 100 francs (£4); and the maximum to 1000 francs (£40).

SECTION 7. Chapter VII and Section 85 of the first book of the penal code are applicable to the above infringements.

SECTION 8. The Government Inspectors of Labour are empowered to determine the infringements by *procès-verbaux*, credit being given thereto, until proved to the contrary. A copy of the *procès-verbal* must, within forty-eight hours, be sent to the infringer under penalty of nullity.

SECTION 9. The present Act will come into force within a year from the date of its publication.

SECOND ROYAL WARRANT WHICH CAME INTO FORCE THE 2ND SEPTEMBER 1910, REPEALING AND REPLACING THE WARRANT OF 13TH MAY 1905, AND REGULATING IN A DEFINITE MANNER THE USE OF WHITE LEAD IN PAINTWORK IN BELGIUM

SECTION 1. In house paintwork, the handling and use of white lead as well as the rubbing down and the

pumicing of surfaces painted with white lead are subject to the following requirements :

Measures Imposed on Master Painters

SECTION 2. Master painters or foremen cannot use white lead, except under the form of stiff paint ground or mixed in oil.

SECTION 3. The handling of white lead, under this form, must be done in such a way as to avoid contact with the substance by the hands as well as the production of splashes. Master painters or foremen will place at the disposal of the staff the articles necessary for this purpose.

SECTION 4. Master painters, foremen, or their deputies must take care that the material and equipment in general are kept in good order.

SECTION 5. Dry rubbing down and pumicing of surfaces, painted or coated with white lead, are interdicted.

SECTION 6. Master painters, foremen, or their deputies must see that the workmen ordered to carry out the operations, mentioned in Section 1 of the present Warrant, wear a garment and a cap exclusively reserved for the work. The clothes which the workmen strip off, to work, must be kept protected from poisonous dust.

SECTION 7. Master painters or foremen must place at the disposal of their staff, both in the working yards and in the workshops, water, the articles and the products required to rinse the mouth, to wash the face and hands with soap, as well as to wipe themselves. Master painters, foremen, or their deputies must take care that their staff undergo these operations before consuming food or drink, and before quitting the workshops or working

yards. The food introduced into the working shops, or brought into the yards, must be enclosed in boxes or coverings kept well closed until meal-time.

SECTION 8. Master painters, or foremen, or deputies will cause the staff employed in the operation mentioned in the first section of the present Warrant to undergo a quarterly examination, by a doctor approved by the Minister of Industry and Labour. The cost of these examinations, on a scale fixed by Ministerial Warrant, must be borne by the master painter or the foreman. Master painters or foremen must remove definitely from work, liable to poisoning, the workman attacked with chronic lead poisoning, and those who exhibit the recurring symptoms of acute lead poisoning. They must remove, temporarily, those whose general health is bad at the date of the examination. They must keep a special register, in conformity with the model delivered by the Administration, and in which the doctor will register the determinations made in the course of his examinations. This register must be sent to the agents of the authority each time it is demanded. Master painters or foremen must not employ workmen addicted to drink; they must forbid the introduction and the consumption of distilled alcoholic drinks into the workshops and the working yards.

Measures Imposed on Workmen

SECTION 9. Workmen who have to handle stiff white lead paint, ground and mixed, must do so in such a way as to prevent the contact of the substance with the hands, as well as the production of splashes.

SECTION 10. Workmen are forbidden to rub down and to pumice, in the dry state, surfaces painted with white lead or coated with white lead *enduit*.

SECTION 11. Workmen ordered to carry out the operations mentioned in Section 1 of the present Warrant must wear a garment and a bonnet exclusively reserved for the work. They must keep them in good order, and clean, and take them off before leaving the workshops or sheds. Workmen must keep the clothes, which they strip off to work, protected from poisonous dust.

SECTION 12. Before consuming food or drink, and before leaving the workshops or the sheds, workmen must rinse out the mouth as well as wash the hands and face with soap. Food introduced into the workshops, or carried into the yards, must be in closed boxes or coverings kept well closed until meal-time.

SECTION 13. Workmen must maintain in good order the material and tools entrusted to them.

SECTION 14. Workmen are forbidden to introduce or consume distilled alcoholic drinks in the workshops or in the sheds.

SECTION 15. Workmen must present themselves for the medical examinations prescribed in Article 5 of the present Warrant.

Penalties

SECTION 16. Infringements of the requirements of the present Warrant will be punished by a fine of 26 to 100 francs (£1 to £4); in case of a second conviction within a twelvemonth, the minimum fine will be *increased* to 100 francs (£4), and the maximum to 1000 francs (£40).

GERMAN REGULATIONS OF 27TH JUNE 1905, WHICH CAME INTO FORCE 1ST JANUARY 1910

NOTICE REGARDING UNDERTAKINGS IN WHICH PAINTING, HOUSE-PAINTING, COATING WITH "ENDUITS," OR VARNISHING ARE EXECUTED

Having considered paragraph 120 of the Industrial Regulations, the Bundesrat has enacted the following requirements for undertakings in which house-painting, coating with *enduits*, or varnishing are executed.

I. Requirements for Undertakings Involving the Work of Painters, "Enduiseurs," Whitewashers (Distemperers), or Varnishers

1. As regards grinding, mixing, and the other manipulations of white lead and other lead pigments, or their compounds, with other dry substances, the workmen must not be in direct contact with the lead, and must be efficiently protected against the dust which is produced.

2. The grinding of white lead with oil or varnish must not be done by hand, but mechanically, in vessels arranged so that no dust can escape into the space where they work.

This requirement, likewise, applies to other lead pigments; the latter may be ground by hand, provided that the workmen so employed are men of more than eighteen years of age, and that the amount to be ground by one workman in a day does not exceed 1 kilo (2·2 lb.) of red lead, nor 100 grms., say $3\frac{1}{2}$ oz. of the other pigments.

3. Dry scraping with the knife and by pumice stone,

or by the spatula (palette knife) of oil paints, that are not absolutely free from lead must not be done except after previous moistening.

The mud from the *enduit* and the waste from the scraping and the pumicing must be removed before they become dry.

4. The master painter must take care that the workmen who come in contact with white lead pigments or their compounds are provided with painters' blouses, or other similar clothing, and with caps, and that they use them during work.

5. Basins, brushes for the hands and for the nails, soap, hand-towels, must be at the disposal of all the workmen engaged in painting, or on applying *enduits* in "whitewashing" (distempering), or varnishing, in which lead pigments or their compounds are used. If these jobs are being performed in a new building, or in a workshop, the workmen must be able to wash in a spot protected from cold, and to preserve their effects clean.

6. The master painter must keep the workmen who come in contact with lead pigments or their compounds fully informed of the dangers which threaten their health, and deliver to them, when they start work, a copy of the instructions annexed hereto, if they do not already possess one, as well as a copy of the preceding requirements.

II. Requirements for Work in which Painting, Coating with "Enduits," or Varnishing are carried on as Work Connected with Other Industries

7. The requirements of paragraphs 1 to 6 apply to the labour of workmen, who in another industrial under-

taking are exclusively or chiefly employed in painting, *enduisage*, whitewashing, or varnishing, and which use for that purpose, and that not accidentally, lead colours or their compounds.

If this work be carried on in a factory or yard the requirements of paragraphs 8 to 11 also apply.

8. A special place must be at the disposal of the workmen to wash and dress themselves; this space must be kept clean, heated in cold weather, and installed in such a way that the clothing may be [classified and] arranged (? hung up separately).

9. The master painter must issue obligatory regulations for the workmen, which must contain, as regards workmen who come in contact with lead pigments or their compounds, the following requirements:

(1) Workmen must not drink brandy on the place where they work.[1]

(2) Workmen must not eat or drink, or leave their place, where they are at work, without taking off their working clothes and having carefully washed the hands.

(3) Workmen must use the clothes for the work, on jobs for which that is prescribed by the master painter.

(4) It is forbidden to smoke cigars or cigarettes during work.[2] In addition, the regulations issued must contain a warning, that workmen who, in spite of repeated

[1] TRANSLATOR'S NOTE.—Beer containing free acetic acid is surely more dangerous than brandy. The painters of Scotland, if they drink anything, mostly drink whisky, and with them white lead poisoning is practically unknown. But undoubtedly they are as a class a better type of men than the general run of those of their English colleagues who suffer from white lead poisoning.

[2] TRANSLATOR'S NOTE.—What about a pipe, and what about tobacco chewing, to say nothing of snuff?

warnings, infringe the above requirements may be summarily dismissed without notice.

If a set of workshop regulations be made on a job (paragraph 134 of the regulation of industry) the above requirements must be included therein.

10. The master painter must entrust the supervision of the health of the workmen to a medical man, authorised by the Superior Administrative Authority, and approved by the Inspector of Labour, to whom his name is given (paragraph 139 of the regulation of industry). This doctor must, in less than a week, assure himself that the workmen do not show any signs of lead poisoning.

The master painter must not allow the workmen who are attacked by lead poisoning, or are, according to the opinion of the doctor, suspected of being so, on jobs in which they come in contact with lead pigments or their compounds, until completely cured.

11. The master painter must keep, or cause to be kept, by an employé, a book for the control of the effective number of his staff of workmen, changes, and their state of health. He is responsible for the accuracy and truth of what is mentioned therein, so long as it is not the doctor who is the author of it.

This control-book must contain:

(1) The name of the person who keeps it. (2) The name of the doctor entrusted with the supervision of the health of the workmen. (3) Surname, Christian name, age, address, date of entry and departure of each workman mentioned in paragraph 11, as well as the nature of their occupation. (4) Date and nature of illness of each workman. (5) Date of cure. (6)

Date and results of general medical inspection prescribed in paragraph 10.

10. The control-book must be at the disposal of the inspector of labour (paragraph 139 of the regulation of industry) as well as the competent functionaries of the Medical Service.

12. The preceding requirements will come into force on 12th January 1906.

Instructions follow concerning lead, indicating the signs and manifestations of plumbism ; then the preventive measures to take to avoid its attacks.

These German regulations are unequalled in detail, and all the requirements which they contain are the product of the purest logic and the most profound knowledge of the question treated, as well as the results to be expected from it. It shows a spirit of deliberation, reflection, and of real competence on the part of the persons who collaborated in its study ; contrary to the French Act, so incoherent, made first of all in haste, revised, remodelled, worked at for eight years, and none the better for all that, neither as regards clearness or the integrality of its application, for it leaves such a vast field, too vast to annoying interpretations and to evasions facilitating its non-observation.

THE SWISS ACT

Following up the report of the Commission nominated for the examination of the draft of the Act elaborated by the Council of State, and which this Commission

altered somewhat drastically, the Grand Council of the Republic and Canton of Geneva passed the Bill thus amended on the 26th October 1906.

On the Use of Lead and its Compounds in Public Works and in Private Building Works

The Grand Council:

On the proposition of the Council of State, amended by the Commission—

Whereas it is necessary to take police measures, so as to prevent the danger which the use of lead and its compounds in public works (buildings, bridges, canals), and in analogous private works, whether in what concerns house-painting or as regards piping—

Decrees as follows:

Section 1. In public works, buildings, bridges, canals, and in analogous private works white lead must not be handed to the workman and employé except in the state of stiff paint, and not as dry powder, whether for painting or for piping.

Section 2. In these same works, it is forbidden to use, directly with the hand, products with a white lead basis; it is also forbidden to dry pumice, or to burn old paint-work.

Section 3. In these same works master painters and workmen must conform to the hygienic requirements prescribed to them. The Council of State is entrusted with elaborating the necessary regulations required for the purpose.

Section 4. Master painters must hand to workmen and affix the text of the present Act, and all the require-

ments of the regulations relative to the same subject, either in the offices where the men are taken on and paid off, or in the yards and in the fixed property where the work is being executed.

SECTION 5. Master painters and workmen who infringe the present Act, or the regulations, will be handed over to the pains of the police.

AUSTRIAN REGULATION

I. ORDER OF 13TH APRIL 1908, OF THE MINISTER OF COMMERCE, IN AGREEMENT WITH THE MINISTER OF THE INTERIOR, REGARDING THE STEPS TO BE TAKEN FOR THE PRESERVATION OF THE LIFE AND THE HEALTH OF WORKING PAINTERS

1. All the spaces in the workshop, intended for whitewashing, varnishing, painting with white lead or compounds with a lead basis, if it be a case of new buildings, must conform with the requirements of the ministerial order of 22nd November 1905. If the workshops are already old, they must be rendered capacious, well ventilated, and capable of being heated. In any case, the walls, ceilings, and floors of the closed places in question must be capable of being easily washed. These places must be kept in good order, and cleaned by washing.

2. Master painters who employ more than twenty workmen on whitewashing, varnishing, or painting must keep in their workshop, at the disposal of workmen, a heatable space to wash themselves and change their clothes, installed in such a way as to preserve the latter,

likewise with a refectory (eating-room). They must see to the constant good order of these places.

II. Special Requirements to be Observed in Following this Trade

3. In the case of whitewashers, varnishers, painters, and others of the same kind, paints and mastics (putties) with a lead basis must be enclosed, and only taken delivery of in vessels or receivers on which there is inscribed, in a legible manner clear and visible (!), the percentage of lead in the contents.

4. (1) The industrial use of white lead, or of other paints and mastics (putties) with a lead basis, is forbidden in indoor painting. (2) This order includes, as works of indoor painting, all those which, as far as concerns the property of durability, are not exposed to the action of the weather. (3) The above interdiction does not apply to works, the object of which is the renewal of a first coat, so as to make an entirely white coat on the same old paintwork, with a lead basis, or the renewal of paintings in spots where the paint is frequently exposed to the effects of water and other vapours. (4) Exceptionally, and by submitting to the above precautions, the authority may allow the use of the products, mentioned in (1), for indoor work, when it is a case of works, which would otherwise be lost to the industry of the country.

5. Women and young assistants must not be put to work with white lead and other products with a lead basis, described in paragraph 4 relating to whitewashing, varnishing, and painting. This interdiction applies also, as regards the young assistants, to the cleaning of the

places mentioned in paragraph 1, and the effects of working described in paragraph 8 [? paragraph 7]. The cleaning of the effects of working must always be done by washing. Exception is made in favour of young apprentices who have passed their fourteenth year. They may be put on to the work, referred to in the first paragraph, for the time strictly necessary. However, this time should not exceed six weeks.

6. The assistants whom the master painter knows to be attacked by white lead poisoning cannot be again taken on, until after they are completely cured, certified by the doctor, and their fitness for working in white lead, or products with a lead basis, has been established. They must not be employed on works, such as the cleaning of the working places indicated in paragraph 1.

7. The grinding and making into paint of white lead and products with a lead basis, as well as the mixing with oil or varnish, must not be done by hand, but mechanically, and in such a way that in running in or in transferring the materials with a lead basis, the workmen are protected from dust, which should not be present in the working places. However, if need be, a single workman can hand-grind weekly a quantity of 3 kilos (6·6 lb.) of red lead, and 500 grms. (1·1 lb.) of other plumbiferous pigments, with the exception of white lead. Rubbing and pumicing of paint or mastics with a lead basis must be done after having previously moistened them. The waste produced by this operation must also be removed in the wet way. On buildings, the works mentioned in paragraph 4, sub-paragraphs (3) and (4), when they are not in the open air, must be carried on in places for the

purpose and where care is taken to mark clearly, and in a legible manner, that there white lead or other products with a lead basis are being wrought.

8. The master painter must see that the workmen who work with lead or with lead compounds use a special working garment and a mask which must be afterwards cleaned; in undertakings employing more than twenty workmen the master painter must furnish the overall and the appropriate mask, and see to the regular cleaning of these accessories. Moreover, the master painter must place at the disposal of the workmen who work with white lead, and products with a lead basis, drinking water, water to wash with, washstands, brushes, soap, towels, in sufficient quantity and in good condition. The master painter must furnish to workmen working with white lead, or products with a lead basis, in the case of jobs producing dust in enormous quantities, a respiratory apparatus [! ! !].

9. In the dwellings reserved for the assistants, neither white lead nor any other product with a lead basis must be deposited nor handled there.

10. Workmen, handling white lead and products with a white lead basis are obliged to use, when fit and proper, the overall and the mask which is reserved for them, and to use on all jobs producing much dust the respiratory apparatus which belongs to them. These workmen must, before eating and after working, thoroughly wash the face, the mouth, and the hands. Moreover, these workmen must abstain, on the job, from the luxury of brandy and spirituous drinks, and from tobacco (cigars, cigarettes, pipes, chewing tobacco, and

snuff). They must consume their food and their drink—the preservation of which in the places of working is strictly forbidden—in places specially reserved for that purpose, and only during the hours indicated, outside working hours.

III. Regulations as to Special Supervision

11. This order must be exposed in a capacious place, in the places where white lead, or products with a lead basis, are being wrought, and it must be kept in such a condition that it can always be read. To each workman, intended to work with white lead or with products with a white lead basis, there is delivered, gratuitously, on entering, a copy of this order. These workmen are placed on a special list. The master painter must see that the workmen in question, on the appearance of the first signs of white lead poisoning, are declared on the sick-list, to the doctor. Where more than twenty workmen are employed, the master painter must so arrange that those who work with white lead and products with a lead basis are at least, every three months, inspected by a doctor as to the signs of possible lead poisoning. In the case of those who might be attacked, there must be put on the list mentioned in the previous clause each inspection by the doctor, and the result must be shown. These lists must be produced, on demand, to the Government inspectors.

IV. Penalties Prescribed

12. Each infringement of these regulations will be, according to the ministerial order of 30th September 1857,

judged by the Tribunal of Commerce, unless such infringements are submitted directly to the Common Penal Laws, or unless they are amenable to the Ordinance of Labour.

V. Date of Coming into Force of the Regulation

The present order will come into force on the 1st April 1909.

This regulation, which we have thought it right to give in full as an example of a type destined to a forced inapplication, is certainly the most badly conceived of all. It is, at the same time, mischief-making, uselessly minute, detailed, incoherent, drastic, and vexatious. Moreover, the reader of these different regulations will quite share with the Author the wishes of the Belgian painters, who preferred and asked on several occasions to have white lead radically suppressed, as in France, rather than submit to any regulation whatever, this method being always difficult of application and containing abusive or vexatious clauses, attacking the dignity of the individual, and at the same time a source of permanent worry and conflicts.[1]

[1] Translator's Note.—But these same Austrian regulations appear none the less to have had a most marvellous effect in the diminution of white lead poisoning, *vide* Mr. Miller's lecture on the white lead question before the Paint and Varnish Society of London. The State regulation of painting, with white lead should have a fair trial, and the painter educated to see and appreciate that what is being done is for his benefit. Want of tact in enforcing the regulations amply explains the hostility of the painter, no matter how well worded the regulations may be.

CHAPTER XII

METHODS OF QUALITATIVE ANALYSIS[1]

EXAMINATION OF PAINTS—FIXED AND ESSENTIAL—OILS—WAXES—FORMULÆ FOR ENCAUSTIC AND WATERPROOF PAINTS

IF it be always useful to indicate the means of fraud, it is none the less useful to point out the methods of detecting and determining that fraud. If some of the Author's colleagues object that the painter is not a chemist, or that he has not the time to do his own analyses himself, the Author replies that that is precisely a great drawback to the trade, not to be able to recognise the exact value of all products purchased, and that proves once more that a certain amount of chemical knowledge is indispensable to the painter who wishes to conduct his trade in a proper manner. It may be further said that he does not lose his time in instructing himself as to the exact value of the products which he must use.

[1] TRANSLATOR'S NOTE.—The painter who expects to find a royal road to the chemical testing of paints will be disappointed unless his instructor is an expert paint analyst. The Author is no doubt a safe guide as a painter. But *ne sutor ultra crepidum*. The numerous annotations to this chapter by the translator will prevent readers from being misled, and, it is to be hoped, prove that a little knowledge is a dangerous thing, and as a warning to those slipshod workers who think themselves experts.

Moreover, the object of the Author is not that the painter should make complete analyses. The Author is more modest, and simply wishes to advise the painter to satisfy himself by means of an examination, easy enough made, if the product he wishes to judge is pure or fraudulent. In recognising the purity, the painter is pacified and feels secure. In detecting the falsification, he knows at least what to expect as to the qualities of the product, as well as to the results of a complete chemical analysis, which he can then entrust to a laboratory. He knows that it will not be useless, and that the money expended in getting it done will not be lost.

Now, in popularising the methods of research given further on, there is placed before the painter the possibility of detecting fraud with certainty, and even of determining its nature. The Author believes that a little science never hurts—at least when one keeps within due limits. These limits will not be exceeded here, and the Author exhorts his colleagues not to go beyond where he desires to lead them. That said, let us begin.

The object of a chemical analysis is to determine the elements of a compound. There are two kinds of analyses —the one termed *qualitative*, by means of which the nature of the elements constituting the body examined are recognised; the other termed *quantitative*, by which the proportions of these elements are determined. When both methods are used, the result forms a complete analysis.

The methods of analysis differ greatly, and depend on the state of aggregation of the body examined; thus gaseous compounds cannot be analysed by the same methods as the solid compounds with which we are

specially concerned, and for which two methods are used—(1) the dry way, and (2) the wet way. Of these two methods, the wet way is the one which can be used by the painter to assure himself, first of all, of the purity or falsification of a product in which he is interested, afterwards to determine the nature of the substances used to falsify it. This method is, moreover, amply sufficient, since it can furnish all the indications desired to satisfy the tradesman as to the actual condition of the products which he uses. It is therefore only necessary to describe here the wet method alone, since it responds in a perfect way to the special needs which the Author has in view in publishing this small course of practical analyses. Only qualitative analysis is dealt with, much more simple, free from all calculations, and very efficient, since it reveals fraud in quite an assured manner.

Of what importance is the amount of the impurities present, as soon as one is satisfied that the product examined is falsified, and from the moment one is certain there is fraud, the refusal to accept delivery of the product examined is amply justified. Let us explain here some essential principles. The analysis of a compound is based, solely, on the action of one body on another body, when put in presence, in direct contact, and under the circumstances required to give rise to a phenomenon termed reaction; the body producing the reaction is termed a reagent.[1]

EXAMPLE I. *Tincture of Iodine as a Reagent for Starch.*—

[1] TRANSLATOR'S NOTE.—The painter who merely dabbles in paint-testing should have his results confirmed before he takes the responsibility of refusing to accept delivery. A reagent need not be a materialised

If a little starch paste be placed in contact with tincture of iodine, the paste immediately assumes a blue coloration, which shows that iodine is an energetic reagent for starch. [Detection of starch in water extract from Prussian blue.]

EXAMPLE II. *Sulphuric Acid as an Agent for Baryta and Lead.*—On the other hand, sulphuric acid, added to [acid] solutions containing baryta or lead, forms a precipitate indicating the presence of these bodies in solution. Sulphuric acid is thus a reagent for baryta and lead. That does not mean that it is the only one.

Here follows a list of the principal reagents used in the wet way. These products are, for the most part, known to the painter, but he ought always to have them at hand to execute any researches that may be necessary:

1. NITRIC ACID, HNO_3 (*Aqua Fortis*).—Used to dissolve materials insoluble in water—chiefly metals and their alloys.[1] By mixing nitric acid with hydrochloric acid (spirit of salt) *aqua regia* is formed, which has the property of dissolving gold which is not attacked by any single acid, not even by these two until mixed. *Aqua regia* is also used in the analysis of vermilion.

body; for instance, cold is a reagent; a linseed oil that freezes at 32° F. is a falsified linseed oil (but that is not to say a linseed oil that stands this test is pure). Heat, again, is a reagent, an "ivory" black that leaves a blue ash is faked up with ultramarine, a brown ash with Prussian blue, a spirits of turpentine that gives off an inflammable vapour much below blood-heat is falsified, so also is a vermilion that leaves an appreciable amount of ash.

[1] TRANSLATOR'S NOTE.—Nitric acid is of value in paint analysis chiefly as a solvent for white lead. The painter who "dabbles" in analysis would do well to replace it for this purpose, where practicable, by acetic acid, as less dangerous. These two acids are the only solvents which yield really soluble salts with lead.

2. Hydrochloric Acid or Muriatic Acid, Spirit of Salt, HCl.—Used in many cases. Like nitric acid it is used to dissolve many substances which water does not dissolve. It attacks lime and lime salts energetically: that is why it is used to clean and bleach marble and stone.[1]

3. Sulphuric Acid, H_2SO_4 (Vulg., *Vitriol*).—Used to detect, in analysis, the presence of chlorides and fluorides; it attacks baryta and lead, in solution, in which it gives a precipitate of these metals. Having a great affinity for water, it effervesces [with dangerous spurting out of the strong acid] by mere contact with it; it is then very dangerous to handle owing to the heat disengaged and the caustic principle it acquires.[2]

4. Sulphuretted Hydrogen, H_2S.—The best reagent for detection of metallic oxides, which it precipitates from their [acid] solutions without [precipitating] the alkaline or earthy salts in the solutions.

5. Sodium Sulphide, Na_2S, replaces the preceding for the same purpose; it is even preferable, in some cases, because it is more stable and more practical. Sulphuretted hydrogen does not keep, and can hardly be used, except in a laboratory possessing a special permanent apparatus for producing it. Sodium sulphide detects lead in a compound by a black precipitate of sulphide of lead.[3]

[1] Translator's Note.—Best and only available solvent for red oxide of iron, which should be digested on a hot sand bath with the strong acid. The dilute acid will not do.

[2] Translator's Note.—Add the acid to cold water, never *vice versa*. On no account must the acid be added to hot water.

[3] Translator's Note.—But mercury, bismuth, copper, iron, nickel, and cobalt all yield black sulphides. When a zinc oxide turns brown

6. OXALIC ACID (Vulg., *Salts of Sorrel*), attacks lime, which it separates from its solution. This acid also precipitates [lime from] all lime salts.

7. AMMONIA (liquid) (Vulg., *Volatile Alkali*).—Ammonia is used to detect, in solution, salts of potash, soda, baryta, and lime—that is to say, the carbonates and the sulphates of these materials which it separates from their vehicle [? solvent].[1] Ammonia does not attack earthy salts [? in solution], which enables the former to be distinguished from the latter. At the temperature of 60 to 70° C. ammonium salts (ammonium acetate, carbonate, chloride) may dissolve and crystallise the mineral and metallic sulphates which are slightly soluble in water [*e.g.* solubility of lead sulphate in ammonium acetate]. Ammonia is the solvent used in paintwork to remove the wax used under the form of encaustic on many jobs.

8. POTASH, KHO, precipitates all earthy salts; it may even redissolve the precipitate, if used in excess.

8*a*. [SODA, NaHO, may replace potash for most purposes. As a rule, it acts similarly.]

or black when drenched with a solution of this reagent or by ammonium sulphide, then it should be rejected if the paint is to be sold as standing sulphuretted fumes. Ammonium sulphide is the reagent used to precipitate those metallic oxides which are not precipitated by H_2S from an acid solution, *e.g.* iron, chromium, aluminum, zinc, manganese, nickel, cobalt.

[1] TRANSLATOR'S NOTE.—Solutions of alkaline salts give no precipitate, those from solutions of salts of alkaline earths are soluble in ammonium chloride. Neither barium carbonate nor sulphate is soluble in water, and if barium carbonate dissolves in nitric and other acids, it is not reprecipitable as carbonate unless by an alkaline carbonate, Barium sulphate is insoluble in nearly all ordinary vehicles.

9. CARBONATES (of potash soda and ammonia).—They likewise precipitate all earthy salts and the metallic salts. They do not attack alkaline salts. Carbonate of potash is used more especially to distinguish in an analysis these latter salts, because these are the only ones which do not give a precipitate with it.[1]

10. YELLOW PRUSSIATE OF POTASH, $K_4Fe(CN)_6$, is used to detect iron salts. It is a very sensitive reagent for these salts, which it precipitates from their solutions: (1) as a white precipitate in the case of protoxide of iron (ferrous oxide, FeO); (2) as a blue precipitate in the case of the peroxide of iron (ferric oxide, Fe_2O_3). [The white precipitate turns blue in the air.]

11. ALCOHOL, C_2H_5HO, is a solvent of many substances insoluble in water; it is used comparatively for that purpose. It serves, amongst other things, to detect sulphate of lime or plaster which is quite insoluble in alcohol. [*Ammoniated alcohol* (liquor ammonia 1, alcohol 1) is the best solvent to use to extract coal-tar colours from lakes so as to leave the barytes or red lead, or other "basis" or "substration" dyed by the coal-tar colour, naked and bare in their primeval condition.][2]

12. BARIUM CHLORIDE, $BaCl_2 2H_2O$.—It is used to distinguish the presence of sulphuric acid in compounds by precipitating solutions containing a sulphate. [The solution must be acidulated by hydrochloric acid.]

[1] Precipitates thrown down by alkaline carbonates do not dissolve in ammonium chloride, like those effected by caustic alkalies.

[2] TRANSLATOR'S NOTE.—But when sulphuric acid and alcohol give a precipitate with a solution it does not follow that it is one of sulphate of lime; it may be, and in the case of a paint very likely is, lead sulphate, or, more likely still, a mixture of both.

In addition to these reagents, it is necessary to have distilled water at hand, because it alone can be used for analytical work. Litmus paper is likewise necessary in many cases for detecting the least trace of acid in solution, this paper reddening in contact with the weakest of acidulated solutions. [It even responds to carbonic acid.] Finally, a platinum wire must be procured, by means of which the sure and rapid detection of certain substances used to falsify paints—salts of baryta and lime especially—may be detected. It is true that the use of a platinum wire entails a bunsen burner with jet or a blowpipe.

ANALYSES OF PAINTS — WHITE PAINTS — ANALYSIS OF WHITE LEAD.—It is superfluous, we believe, to tell painters that white lead is outrageously falsified in commerce; the pure [*sic*] quality sold by ordinary merchants [in France] contains 10 per cent. of barytes.[1] It can hardly be obtained absolutely pure [in France], except when expressly ordered; the other qualities on the French market have a barytes content of 50 to 60 per cent., and sometimes more.

But it must be borne in mind that if it be so it is greatly the faults of the painters themselves, or, to be more exact, of the far too large a list of painters who always wish to purchase as cheaply as possible, and to whom goods are supplied to correspond with their money.

There is, however, a difference as regards yield and work with a good quality white lead; the most pure is always the best in all respects. It is not altogether the

[1] TRANSLATOR'S NOTE.—Manufacturers in Great Britain have now agreed to mark all white lead containing barytes as "reduced." The White Lead Corroders' Section of the London Chamber of Commerce tests white lead free of charge and prosecutes in case of gross adulteration.

same as with white zinc, for the manufacture [of white lead] differs essentially, and does not yield in the same operation several sorts of white lead. There is only one, and that always yields a pure product. The difference in price is due solely to the sophistication of this initial product, which is subdivided into sorts or numbers by great reinforcements with barytes, sulphate and carbonate of lime, sulphate of lead. [But German differs from stack white lead.]

To ascertain whether white lead is sophisticated, it is necessary, in the first instance, to proceed as follows, namely, to free the stiff paint from oil by treatment with benzine; a test tube is used—a glass tube which can be got at all good druggists or pharmacists. A small amount of the white lead to be tested is placed in this tube, and then covered with benzine, which is then shaken, closing the mouth of the tube with the thumb. The two products mix. The whole is then allowed to stand; when all the liquid floats on the top, it is decanted, and the operation repeated four or five times, so as to extract the whole of the oily constituent of the stiff paint. The product thus dried is treated with nitric acid, diluted with its own weight of water, and heated gently by holding the tube above the flame of a small spirit lamp or any other source of gentle heat. Either complete solution of the substance or partial solution [with evolution of CO_2], leaving a residue or deposit, takes place. If solution be complete, the white lead may be regarded as pure [? presence of chalk], but if there be a residue or any deposit whatever that shows that it has been falsified by one or other of the products above mentioned, the nature of which may be determined by the following methods:

1. *Detection of Barytes in the Residue from the Solution of White Lead in Nitric Acid.*—A very small amount of the substance left in solution is lifted by the tip of a platinum wire, and the tip then moistened slightly in spirit of salt (hydrochloric acid), and the end of the wire held in the flame of a bunsen burner, or in that of a blowpipe, and the coloration of the flame then produced carefully observed. If the flame be coloured green, that proves irrefutably the presence of barium, and therefore one of its salts barium sulphate (barytes).[1]

2. *Detection of Sulphate of Lead in the Residue [if any] from the Solution of White Lead in Nitric Acid.*—Taking once more a portion of the residue [if any] formed by the incomplete solution of the white lead in dilute nitric acid, and mixing this fresh part with dilute hydrochloric acid, and boiling it in the test tube, and filtering and adding chloride of barium to a portion of the liquid so filtered, if a white precipitate occurs it indicates sulphuric acid, thus indicating the presence of a sulphate. Sulphuretted hydrogen or sodium sulphide is then added to a fresh

[1] TRANSLATOR'S NOTE.—The hydrochloric acid must be pure. That is a *sine qua non*, and the purchaser is not like to get it pure if he asks for it as "spirits of salt." Besides, this green coloration of the flame is only an indication. This test is very delicate and it would be wrong to come to rash conclusions. Even a less amount than a quarter of a per cent. of borate of manganese would respond to this test, and if this drier were present in the paint or oil the residue from the nitric acid might be contaminated with boracic acid through faulty extraction and washing, such as would be done by an untrained painter, etc. The Author says nothing of washing the residue with hot distilled water, but unless this be done thoroughly and pure acid used the flame may show all the colours of the rainbow, *e.g.* copper salts colours the flame green.

portion of the liquid, and if a black precipitate is formed sulphate of lead is present.[1]

The residue may be placed to digest, or the deposit left to dissolve in a concentrated solution of carbonate of soda, which on the one hand yields sulphate of soda which is characterised or detected by barium chloride [after acidulation by hydrochloric acid] as already seen; on the other hand, this concentrated solution yields lead hydrate, which is recognised in the same way as the sulphate of lead by sodium sulphide.[2]

3. *Detection of Sulphate of Lime (Gypsum or Plaster Stone) in the Residue from the Solution of White Lead in Nitric Acid.*—Sulphate of lime (gypsum) is distinguished, on analysis, from sulphate of barium (barytes) by being soluble in hydrochloric acid in excess. It suffices, therefore, to place a portion of the residue originally obtained in spirits of salt (hydrochloric acid); if solution occurs, it is a case of sulphate of lime and not of sulphate of baryta. This research may be preferably carried out by treating

[1] TRANSLATOR'S NOTE.—The first test, that for sulphuric acid, owing to the interference of the lead chloride, is not very reliable and lead sulphate is far from soluble in HCl. Again, in the second test if the residue is not thoroughly washed with boiling water, lead is sure to be found in any case, whether lead sulphate (rarely present) be present or not. One should always test the residue from the nitric acid with ammonium sulphide to see whether the nitrate of lead has been thoroughly washed out.

[2] TRANSLATOR'S NOTE.—The product of the reaction of carbonate of soda on lead sulphate is white lead [not lead hydrate] and sodium sulphate. Sulphate of lead can only be present if the *well-washed* residue itself blackens with sodium sulphide. If it does so, digest the residue with ammonium acetate, acidulate with pure acetic acid and add barium chloride; a white precipitate indicates sulphuric acid. If the residue consists wholly and solely of lead sulphate, ammonium acetate will give a complete solution.

the residue with carbonate of soda in solution, then determine the presence of sulphuric acid by barium chloride as already described; as to the lime, it will be detected by the coloration of the flame with the platinum wire, as has been explained in the detection of sulphate of baryta, but in this case the flame will be coloured a strong [brick] red. [Gypsum dissolves in sodium hyposulphite.]

4. *Detection of Carbonate of Lime or Chalk.*—Carbonate of lime dissolves in dilute nitric acid along with the white lead [see paragraph 1]. It is not, therefore, by treating the residue that it is detected, but by operating on the solution itself (white lead freed from oil, then dissolved in acid). A portion of this solution is taken, to which sulphuretted hydrogen is added in excess; sulphide of lead is then precipitated, which must be filtered off, sulphate of soda added in solution, and alcohol to twice the volume of the liquid. If a white precipitate occur, the presence of lime is indicated, and it may be controlled further by means of the platinum wire in the flame, which becomes red [after dipping in HCl].[1]

Instead of operating in the first instance by extracting the oil from the white lead paint, the latter may first of all

[1] TRANSLATOR'S NOTE.—Substances cannot be separated by any manner of means in the hard-and-fast or absolute way which the Author seems to imagine. Lead is not at all easily precipitated in a complete manner from its solutions especially in presence of zinc. The solution is either too acid when lead remains in solution or too neutral when zinc remains in solution. No one but a trained chemist can separate lead properly, and if any remain in solution it will infallibly give a precipitate with sulphate of soda. *N.B.*—It is difficult to wash lime salts that have been in contact with carbonate of soda, so far free from soda that they do not colour the flame yellow and mask the brick red of the lime.

be calcined in a porcelain crucible or other non-metallic vessel on the fire; the residue from the calcination are salts of lead and other products (impurities) which have only to be recognised by reactions already given for the successive treatment of the residue left by nitric acid.[1]

ANALYSIS OF WHITE ZINC

Two salts [*sic*] of zinc are utilised in painting the oxide and sulphide. The latter possesses a really superior covering power, but it has the drawback of being altered by sunlight, which turns it grey very rapidly. Zinc sulphide is the active and covering ingredient of lithopone, of which sulphate of baryta is the inert element—the make-weight! It is to the presence of this salt of zinc that the blackening of lithopones or their yellowing, after the drying of the paint, is for the most part due. It has also the drawback of precipitating at the bottom of the keg, without however hardening like red lead. Great and good things had been claimed for this product, with more covering capacity and more durability than its associate, zinc oxide. But in spite of an active propaganda, and of its very considerable properties, it does not seem to enjoy the vogue of the oxide, better known under the name of white zinc, and which remains preferred by many in painting, because of its perfect fixity [of colour]. White zinc is not falsified to such an extent as white lead, the latter, owing to its properties of covering power and

[1] This latter method is not to be recommended, nor is the precipitation of lime from a solution from which the sulphuretted hydrogen has not been boiled off.

durability, being in a better position to support fraud by the addition of inert matter, but white zinc is very often mixed with white lead, and that in notable proportions.

To detect lead in white zinc, sold as such, or any other paint composition, said to be white zinc, reagents are used which detect lead instantaneously. Every paint, every stiff white paint or pigment in contact with sulphuretted hydrogen, sodium sulphide, or ammonium sulphide, assumes the black coloration of lead sulphide if it contains white lead [direct process, zinc oxide, lead sulphate, or sulphite].

If it be desired to detect zinc in a white pigment, it is acted on in an acid medium by one of the above reagents to separate the lead as sulphide,[1] the solution is [filtered], neutralised by ammonia, and the zinc will then give a white precipitate of zinc sulphide.

Barytes, if present, is detected by the methods already given for detecting that body or barium.

Tungsten White, *Magnesia White*, *Copper White*.—These three pigments, which in succession were to work such wonders, have not yet gone beyond the laboratory, where it appears they must remain. There is, therefore, no occasion to point out the method of their analysis.

Chalk White (*Paris White*), *Meudon White*, *Spanish White*, *Champagne White* [*Whiting*].—Their generic and scientific name is, carbonate of lime. These bodies are inert in oil, but form with it very practical and economic

[1] Sulphuretted hydrogen is the only reagent that will separate lead out as sulphide satisfactorily, and then only if the solution be not too strongly acid, otherwise lead would be left in solution and the ammonia precipitate would be black instead of white in the presence of zinc. To precipitate the zinc properly it is better to add ammonium sulphide after neutralising with ammonia.

mixtures under the form of mastics and *enduits* [putties, etc.]. They are especially used in distemper painting with size, of which they form the basis and the solid ingredient. They are also utilised for special distemper paints, termed washable distempers, conjointly with the base of these paints formed by barium salts (sulphate of barium) and zinc salts (oxide and sulphide), to which is added an alkaline silicate as a binder, in conjunction with carbonates of soda or potash, or again by introducing casein into the cretaceous mixtures. All washable distempers fall into one or other of these classes—Malolin, Solo, Aquatinta, Euchromine, etc. However, these paints are only washable in a comparative manner, because all their separate elements are soluble in water, and their admixture gives rise to no real chemical combination, to no transformation of their nature; they are more or less soluble, and do not resist a somewhat long-continued washing. [Acetic, nitric, and hydrochloric acids all dissolve Paris white with evolution of CO_2.]

Lime.—Essential basis of the classic and rudimentary whitewash, it yields a bright white, and combines with water which slakes it, producing thus a paint which is really washable or rather *insoluble* when dry. Lime should be preserved in lumps enclosed in a receptacle always kept closed.[1]

[1] Otherwise air-slaked lime would be produced a useful article, for some purposes, but in which the lime has lost its causticity and hence some of its virtues; in one word, it is more less carbonated, and this carbonatation should take place on the object on which it is applied. The lime has lost the virtues of lime as an insecticide and germicide and disinfectant generally, and is, in fact, reconverted back again into an inert substance with all the properties of chalk.

The great drawback of painting with lime is that it scales off greatly after a comparatively short time, and that, moreover, to renew it must be scraped off sharply and completely.

The Author recently learned that a Paris house was about to put a substitute on the market at the same price, serving the same purpose, with the same properties, but with none of the above drawbacks. That would be very nice if it were true.

Blacks

Blacks used in painting (carbon black [gas black], light black, ivory black [bone black]) are analysed, by calcining them with access of air, which gives with ivory black a small amount of white ash; with bone black the ignition is more difficult and leaves much ash.[1]

Vegetable black [lamp-black] readily ignites, but it yields no ash.[2]

When the black to be analysed consists of substances of different origin, which is almost always the case with

[1] TRANSLATOR'S NOTE.—Trade ivory black is often bone black, and too often spent char. Bone black faked up with Prussian blue leaves a brown ash, which dissolved in hydrochloric acid and oxidised with nitric acid, yields a blue precipitate with yellow precipitate; if faked up with ultramarine blue it leaves a blue ash, which drenched with hydrochloric bleaches and gives off fumes which blacken filter paper dipped in a solution of basic acetate of lead. Pure bone black yields a white ash completely soluble in HCl. The solution neutralised with ammonia gives a white precipitate with ammonium oxalate (lime) the filtrate from which gives a white precipitate of magnesium ammonic phosphate (phosphoric acid).

[2] TRANSLATOR'S NOTE.—British lamp-black leaves as a rule 25 per cent. of ash, usually china clay.

common blacks, they produce smoke and ash of doubtful colour.[1]

RED PIGMENTS

Compared with blacks, the red pigments used in painting are very numerous. First of all, the most common is red ochre, which is an argilo-ferruginous earth, like all the other pigments termed ochres or earths.

It is to the presence of iron, in a greater or less state of oxidation, that the difference and diversity in the colour of these earths is due, and which also explains the difference in the vigour of the tone to be observed between identical pigments, but from different sources.

To analyse these ochres, and in general all the earths, they are put to dissolve, in concentrated hydrochloric acid, which attacks and separates the ferruginous colouring principle, which is known by its red reaction.[2]

The argillaceous or earthy principle is detected by its not dissolving but very feebly in nitric acid,[3] and not at all in potash solution.[4]

[1] TRANSLATOR'S NOTE.—All the waste and surplus paint of the factory, instead of being assorted and utilised in paint of an approximate tint, is often made into common black paint; it is better than carting it to the rubbish heap as many badly managed firms do.

[2] TRANSLATOR'S NOTE.—Use a small dry glass flask, run in the dry pigment, avoid touching edges, run the acid drop by drop down the edges so as to wash down any adherent pigment, then cover the pigment in the flask with acid to the depth of ¼ inch above the surface of the pigment. Digest on sand, bath till residue is absolutely white. Use no water but that required for dilution before filtration.

[3] TRANSLATOR'S NOTE.—Anhydrous peroxide of iron is insoluble in nitric acid, and it is no advantage even to use *aqua regia*, as it is more soluble in concentrated hydrochloric acid than in *aqua regia*. The addition of nitric acid to hydrochloric acid intended to dissolve iron oxide hinders solution rather than otherwise.

[4] TRANSLATOR'S NOTE.—This is a mistake. The way to detect

If there is decided solution in one or other of these two products, it is because the pigment contains foreign matter, such as barytes or other silicious products, which are detected as in the case of white lead, by examining the residue left by the pigment after solution in hydrochloric acid.[1]

Red Lead.—A pigment in regard to which it has not been desired to wage the same war as on white lead, although quite as poisonous if not more so in its powdered form, under which it is always sold and must be handled by the painter. Red lead is outrageously adulterated, even in the factory, where different grades, or numbers at prices to be met, by painters at a discount. It is sophisticated with barytes (a product beatified by adulterators), chalk, yellow ochre, colcothar (red oxide of iron).

To analyse and ascertain first of all if it be pure, a little of the dry powder is placed in dilute nitric acid and heated. If the red lead is pure, the powder completely

free alumina in an ochre is to dissolve it in hydrochloric acid and treat the solution with potash in excess, dilute and filter, then acidulate with hydrochloric acid, neutralise with ammonia in slight excess, boil off the excess, and the alumina if present will fall out as a gelatinous precipitate. If the Author means clay, see succeeding note.

[1] TRANSLATOR'S NOTE.—It would be better to proceed to this examination straight away without waiting to test with caustic potash solution, which would in any case give equivocal results. To prove that the residue is merely clay, fuse the residue with fusion mixture in a platinum crucible, run crucible and contents into a porcelain basin, acidulate with hydrochloric acid, evaporate to dryness, drench with hydrochloric acid, add water; the silica of the clay is rendered insoluble. Filter off this silica, add ammonia to the hydrochloric acid solution, boil off; the gelatinous precipitate is alumina, and alumina and silica combined form clay. Clay when breathed on gives off an earthy smell.

dissolves; the presence of any residue is a proof of adulteration.[1]

To detect barytes or Paris white, proceed as in the analysis of white lead; ochres and colcothar or any other ferruginous earth, are detected by treating the residue by concentrated hydrochloric acid. If solution occurs, iron is present, and then the solution should be coloured reddish or rather russet.[2]

[1] TRANSLATOR'S NOTE.—The Author has omitted to mention that oxalic acid or sugar must be added to the nitric acid solution. Nitric acid alone gives a puce coloured residue of lead peroxide, PbO_2. Red lead being $2PbO, PbO_2$, the PbO dissolves in the nitric acid, leaving the pure oxide PbO_2 as an insoluble residue; the action of the nitric acid on the sugar generates reducing gases, which take oxygen from the PbO_2, reduce it to PbO, a compound which dissolves in nitric acid. The best way to perform the test is to place a little red lead, as much as covers a threepenny-piece, in a test tube, treat with enough nitric acid (strong) and no more, to turn the red lead brown, add oxalic acid gently and a drop or two more of strong nitric acid if need be, heat; then when the insoluble residue is perfectly white, fill up the test tube gradually with boiling distilled water; if pure, a clear solution is obtained instantly. Many far too arrogant chemical "dons" (*sic*) get the conceit taken out of them by getting a sample of red lead to test. Nearly one and all fail ignominiously. No painter who knows red lead when he sees it can fail to recognise a pure sample, and *vice versa*. No one can "touch" it without breaking the crystals and absolutely spoiling the colour.

[2] TRANSLATOR'S NOTE.—Solutions of ferric salts are a brownish yellow. But red lead itself dissolves in hydrochloric acid if treated in the right way. Convert the whole of as much red lead as will cover a threepenny-piece into chloride by treatment with strong hydrochloric acid; use enough acid and no more, then deluge the chloride with about half a pint of boiling distilled water. To test for iron add yellow prussiate to this solution; a blue coloration indicates iron. But neither red ochre nor red bricks are used to sophisticate red lead in Great Britain; it cannot be done so as to deceive the practised eye. Besides, the high gravity of red lead and the low gravity of bricks would at once cause suspicion. Red

Orange Lead.—Adulterated in the same way as red lead.[1]

Vermilion.—To analyse vermilion first heat it in the dry way in a retort [porcelain crucible], and as vermilion is a pure sulphide of mercury the heat of the retort [porcelain crucible] should volatilise it somewhat rapidly. If there be any residue[2] its nature may be determined by methods already given. Ochres and ferruginous principles may be detected by methods given under white lead. But if the vermilion be adulterated by the addition of red lead it may be detected by attacking it [? the residue] with nitric acid, heating and adding to the solution a drop of sulphuric acid; if a precipitate forms it is due to lead sulphate, which indicates fraud by some lead salt which most likely is red lead.[3]

If it be desired to go further with the examination, and if the operator desires to satisfy himself of the evident

lead might, however, be adulterated by a red lead substitute made from coal-tar dyes, to detect which mix equal quantities of strong ammonia and alcohol, add to a small portion of the red lead, and boil; a reddish yellow solution often fluorescent indicates a coal-tar colour, hence a red lead substitute.

[1] TRANSLATOR'S NOTE.—Orange lead, so often used for a lake "basis," is calcined white lead, only heated far enough to convert it into red lead, and not into litharge; it contains up to about 5 per cent. of undecomposed white lead, which effervesces when warm dilute nitric acid is added to the orange lead. Orange lead is completely soluble in nitric acid, plus sugar or oxalic acid, like red lead.

[2] TRANSLATOR'S NOTE.—Pure vermilion only leaves about 0·02 per cent. of ash.

[3] TRANSLATOR'S NOTE.—This test and this deduction must not be generalised, because if vermilion is not likely to be adulterated with lime salts, the test unless confirmed otherwise, no more shows lead than it does lime. Lime must either be an unlikely adulterant or it must be removed before applying the test.

presence of mercury, the pigment is first treated with *aqua regia* (see the end of the paragraph on nitric acid in this chapter), heated and filtered [after dilution], then sulphuretted hydrogen is introduced, which forms black sulphide of mercury insoluble in hot nitric acid.[1]

As to artificial vermilion, it will be dealt with under aniline colours.[2]

Carmine and Lakes

(1) *Cochineal Carmine and Carminated Lakes;* (2) *Madder Carmine and Madder Lakes;* (3) *Ordinary Red Lake.*—The first pigment belongs to the animal kingdom and is formed by steeping the dead bodies of the cochineals in water, followed in succession by decantations and pressings.[3]

The second and the third colours are vegetable colours.

The animal lakes are analysed by dissolving them in oxalic acid (salt of sorrel). If pure the solution ought to be of a greenish red colour ; any other coloration than this indicates adulteration.[4]

To detect vegetable lakes two tests are applied—(1) cold water ; (2) ammonia. The solution should remain colourless in both cases if the colours are pure. [The first is rather a test of the fastness with which the dye of whatever nature has been struck on to the base of the lake,

[1] Translator's Note.—The best test for mercury is to separate it as metallic mercury by heating the vermilion in a bulb tube with carbonate of soda, dumping out the contents of the tube to show the beads of metallic mercury.

[2] Translator's Note.—Vermilionette moistened and rubbed on the skin stains it red. Vermilion does not do so.

[3] This only gives an aqueous solution of cochineal. For the method by which carmine is prepared from this solution, see Bersch's *Mineral and Lake Pigments* (Scott, Greenwood, & Son).

[4] Several coal-tar colour lakes would respond to this test.

and some vegetable lakes might give a coloration with ammonia and yet be pure.]

Artificial Red Pigments Dyed by Anilines [*Coal-Tar Colour Lakes*].—The detection of colouring principles with an aniline basis is rather difficult, but traces of them may be detected by simple enough means which suffice to prove there is fraud, by special colouring principles, which must be associated with the bases with the inert matter with which pigments are themselves adulterated. The base in question must, therefore, be detected by the methods previously indicated, whether for ochres, barium salts, carbonate and sulphate of lime.

This basis when discovered is treated by its proper solvent and with the solution so obtained dye tests are made on linen and cotton. If the solutions are acid, the acid is neutralised to prevent any action on the stuff dyed, but in using strips and recalling the effect which should be produced according to the stuff employed; if the stuff be dyed aniline dye is present.[1]

[1] TRANSLATOR'S NOTE.—These instructions are very loose, fabrics of whatever nature too often require a mordant but more especially linen and cotton. Rose pink, carmine, etc. etc., would respond to this test as well as coal-tar colours if mordanted, but neither would hardly do so otherwise. Fluorescence of the dye stuff itself and its solutions are distinctive of coal-tar colours, especially eosins. The following is a useful test for mineral pigments faced up with coal-tar colours. Nearly all coal-tar colours and the compounds they form when struck on a base dissolve in ammoniated alcohol, leaving the base as an insoluble residue. Thus vermilionette is usually red lead, possibly but not always previously reduced by barytes. Extract the eosinate of lead, etc., by ammoniated alcohol, which leaves the red lead plus barytes if any, dissolve the red lead by nitric acid plus oxalic acid, which leaves an insoluble residue of barytes if present.

This research, very delicate to be successful, is very interesting for examining the cheap vermilions and madder lakes thrust on the market, where they are only too widespread.

Yellow Colours

Yellow ochre, analysis already described, and common to all pigments of this nature.[1]

Terra di Sienna Natural. See under "Reds."[2]

Chrome Yellows, Mineral Yellow, Orpiment, Naples Yellow, Indian Yellow, Yellow Lake.—The last colour treated by potash solution is coloured brown.[3]

Chrome yellow treated similarly [to yellow lake, *i.e.* by potash solution] yields a reddish solution.[4]

The other yellows, with the exception of Naples yellow, should dissolve in potash solution if pure.[5]

If solution does not occur, tests are made for products

[1] Translator's Note.—When poor ochres are faced up with chrome yellow to simulate better ochres, when treated with caustic soda solution the lead chrome dissolves with a straw yellow coloration, and the chrome yellow is precipitated therefrom by neutralising with acetic acid.

[2] No one but an expert can test Sienna. The manganese complicates the analysis. The best test is for colour transparency and body.

[3] Translator's Note.—The Author here presumably refers to Dutch "pink," a lake which may be made from quercitron bark, Persian berries, and fustic individually or collectively, but this is a very vague test. See the table of the colour reactions of vegetable dyes in Bersch's *Mineral and Lake Pigments* (Scott, Greenwood, & Son).

[4] But the solution is straw yellow when potash is added in excess; the chrome yellow may turn red at a certain stage before it finally dissolves, but the solution never goes beyond straw yellow.

[5] Orpiment gives cubic and octahedral crystals of arsenic when heated in a glass tube open at both ends.

of adulteration, by operating on a part of the pigment (in powder) or previously freed from oil by extraction or calcination if it be stiff paint. The residue is treated by dilute nitric acid ; if solution is incomplete and difficult it is adulterated by yellow ochre. If solution is effected with rapidity and completely with a reddish-orange coloration there is sophistication by ultramarine yellow, yellow ochre.

Naples yellow, which is almost insoluble in potash solution and in nitric acid, is fused before the blowpipe with carbonate of soda ; if pure it will give very brittle globules.[1]

GREEN PIGMENTS

English Green, Zinc Green, Schweinfurth Green [*Emerald Green*], *Veronese Green, and Emerald Green* [*Guignet's Green*].—As regards the two first pigments one need hardly search for anything but poisonous greens, Scheele's green or Schweinfurth green [emerald green]. The powder to be analysed is boiled in potash solution, as for yellows ; if an orange-yellow solution [?] occurs it shows the presence of one of these two poisonous greens [?], the nature of which may be determined by heating the solution with sulphuric acid and alcohol in equal parts.

[1] TRANSLATOR'S NOTE.—But Naples yellow might be "reduced" very greatly and still give these brittle globules. Ores containing antimony and lead just as this pigment, even if very poor, still give these brittle globules. The only way to analyse Naples yellow is by the wet way. Dissolve in acid, separate both lead and antimony by sulphuretted hydrogen, as lead and antimony sulphides, dissolve the antimony sulphide by ammonium sulphide, leaving the insoluble black sulphide of lead, acidulate the ammonium sulphide solution with hydrochloric acid, and the antimony falls as a brick-red precipitate.

If gas is disengaged with an odour of vinegar [acetic ether rather] Schweinfurth green [emerald green] is present.[1] But if no result occurs Scheele's green is present. Barytes and other common products may be recognised by methods already given by treating the residue obtained with potash solution.[2]

Blue Pigments

Natural and artificial ultramarine, Prussian blue, mineral blue, cobalt blue, blue lake, or Saxon blue. Litmus for distemper. Ultramarine blue and litmus are attacked by hydrochloric acid, which decolorises the first[3] and turns the second red. *Saxon blue* dissolves in sulphuric acid, and is decolorised by bleaching powder. *Cobalt blue* increases in intensity in potash solution. Mineral blue [? azurite refiners blue verditer] is often adulterated by indigo, which is detected by treating the mineral blue with sulphuric acid,

[1] Translator's Note.—The best test for purity of emerald green is to dissolve it in ammonia ; any residue is most likely barytes, but emerald green, like red lead, cannot be "touched" without destroying its crystals and its beauty.

[2] Translator's Note. — The greens used so largely in Great Britain consist of chrome yellow and Prussian blue struck on to barytes, which latter may amount to 98 per cent. of the green. To analyse this green : Ignite it ; the Prussian blue is converted into red oxide of iron and the chrome yellow remains as such. The two latter dissolve in concentrated hydrochloric acid and the barytes remains insoluble. The chrome yellow may be detected by treating the green itself with excess of potash. The chrome yellow is precipitated as such from the alkaline solution by acidulating with acetic acid. To detect green lakes made from coal-tar colours, the best way is possibly to extract the green pigment by ammoniated alcohol.

[3] Translator's Note.—With evolution of sulphuretted hydrogen, smell of rotten eggs, and blackening of paper moistened with basic lead acetate.

which completely dissolves indigo, and itself assumes a blue colour ; if there is any residue it is a clay of some sort.[1]

Analysis of Prussian Blue.—Prussian blue being extensively used in painting, it is advisable to determine its greater or less real degree of purity. It therefore requires a more exhaustive analysis. The usual products of adulteration are added to Prussian blue, sulphate and carbonate of lime, sulphate of baryta, and very often starch. Potash solution decolorises it energetically, which does not occur with other blues. To recognise the presence of sulphate of lime or plaster (gypsum) the blue is mixed with a little nitric acid and heated to boiling ; if a white residue is formed it contains gypsum. To recognise carbonate of lime the pigment is treated in the same way ; if effervescence occurs it is the sign of a carbonate, the nature of which is determined by treating the solution with oxalic acid (salt of sorrel) ; if the liquid becomes turbid, carbonate of lime is present. To detect sulphate of baryta, the blue is treated by hydrochloric acid (spirit of salt) which does not dissolve barytes. The residue is filtered and the platinum wire used as explained, under white lead. A little of this residue is taken on the end of the platinum wire ; it is impregnated with a few drops of hydrochloric acid, and immediately placed in flame of a bunsen burner or of the blowpipe ; if the flame is coloured green, barium is present.[2] Starch

[1] TRANSLATOR'S NOTE.—But azurite would also dissolve in sulphuric acid [with effervescence] and colour it blue. It is difficult to say what blue is meant. The best test for azurite or refiners blue verditer is its complete solution in ammonia. From the mention of clay the Author possibly refers to a cobalt blue or a silicate of copper blue. Indigo is too dear to be used to adulterate painters' pigments.

[2] TRANSLATOR'S NOTE.—The best way to test Prussian blue rapidly

may be detected by boiling a portion of the blue in rain-water, in the absence of distilled water. A drop of tincture of iodine is added; if the water is coloured blue the pigment contains starch.

Brown Colours

Brown Ochres—Raw and Burnt Umbers—Cologne Earth—Cassel Brown—Van Dyck Brown—Mars Brown—Prussian Brown.—To analyse these pigments the powder is treated by hydrochloric, which dissolves all ferruginous browns without disengagement of gas. If otherwise, *i.e.* if gas be disengaged, the colour examined contains a carbonate, the nature of which may be determined by the methods previously given.[1]

Analysis of Binders or Liquids

Analysis of Linseed Oil.—Although generally this oil is but little adulterated, other low-quality oils are sometimes added to give it weight (?) or hide the defects of low-quality linseed oil. The sophistication is then effected

is to ignite it. The residue should consist wholly and solely of iron oxide completely soluble in concentrated hydrochloric acid, the solution giving no precipitate with barium chloride, absence of sulphates, and hence of sulphate of lime. The hydrochloric solution when tested for alumina, by method already given, should give negative results.

[1] TRANSLATOR'S NOTE.—Browns containing complex mixtures of oxides of manganese and oxides of iron and possibly silicates of these metals, like Sienna and umbers and Van Dyck browns, can only be analysed by expert chemists. The test for carbonates is sound enough as far as it goes. Gypsum can be removed from iron reds and browns by digestion with sodium hyposulphite. Barium chloride added to the extract acidulated by HCl gives a white precipitate in the presence of gypsum.

with fish oils, cotton oil, colza oil, poppy oil, finally even with mineral oil.[1]

It is difficult to detect the kind of oil used to adulterate a sophisticated linseed oil, and if it be desired to know it very exactly, the analysis must be entrusted to a professional chemist; but if it only be desired to make investigations to get indications of fraud only, the following are some methods of determining it adequately, and of getting information as to the purity of linseed oil. The suspected oil is tested by nitric acid, by sulphuric acid, by potash, and by heat. Treated by nitric acid, linseed oil, if pure, assumes a greenish coloration.

Treated differently, by this same acid mixed in the proportion of double the weight of linseed oil, the mixture shaken and allowed to stand for a minute, the two products separate; if the oil be pure, the acid layer will not be coloured, but the layer of oil will become orange red. If these two conditions are not fulfilled, the oil is certainly adulterated.

Treated by concentrated sulphuric acid, mixed in equal parts with it, if a red coloration streaked with black be obtained, fish oil is present; if there be a yellow coloration, poppy oil in all probability.[2]

Treated by caustic soda, linseed oil, if pure, does not change colour.[3]

[1] TRANSLATOR'S NOTE.—But such oils, poppy oil excepted, would not hide the defects, but intensify them.

[2] TRANSLATOR'S NOTE.—For fuller and more reliable sulphuric acid and other colour tests for the purity of linseed oil, see M'Intosh's *Oil Crushing, Refining, and Boiling* (Scott, Greenwood & Son).

[3] TRANSLATOR'S NOTE.—It forms *in the cold* a pale emulsion.

To detect the presence of mineral oils, a fragment of carbonate of potash is dissolved in alcohol.[1] A small amount of oil is then added, and the whole brought to the boil for a short time; distilled water, very little, is then added. If the oil be pure, the solution remains limpid; if it be turbid, the oil is evidently sophisticated by mineral oil [or by rosin oil, etc.]. To increase the weight of linseed oil, water may also be introduced, even in rather large quantity. It is detected by heating the oil and observing if the oil bumps and froths; the manifestation of these two things show the presence of an abnormal amount of water, and if it be desired to get quit of it, the oil need only be gently heated and long enough to produce complete evaporation; the disappearance of the froth and the bumping show that evaporation is complete. If on heating the oil an acrid and resinous smell be felt, there is great reason to presume that the oil is sophisticated with rosin oil.[2]

Analysis of Spirits of Turpentine.—This essential oil,

[1] TRANSLATOR'S NOTE.—Carbonate of potash is insoluble in alcohol. Caustic potash is evidently meant.

[2] TRANSLATOR'S NOTE.—There are one or two reliable tests which the painter may perform without any training: (1) Rub the palms of the hands with the suspected oil, as if making a lather with soap to cleanse them. Enclose the nose in a space enveloped by the two palms of the hands in parallel juxtaposition, and take a long snift. If fish oil or rosin oil be present they may usually be detected by their smell. (2) Get a hydrometer, 0·900–0·950, and a thermometer from a scientific apparatus firm. Bring the oil to 60° F. Insert the hydrometer in the oil in a glass jar. It should not sink below 0·930, nor above 0·934 if it be raw oil, nor below 0·937 if boiled oil. (3) The time in which and the manner in which the oil dries is the real test of the purity; and every painter knows how to test that without instruction.

now very dear and the price of which keeps continually increasing, and their famous derivatives, and with the so fashionable white spirit, with resins, which dissolve therein with alcohol and even with water.

Like linseed oil, the analysis of turps is very long, delicate, and difficult, but, as in the case of oils, there are methods of indication. The presence of an inferior grade of essential oil may be detected by a solution of bromine in chloroform, which is mixed in very small quantity with the turps to be tested. If the turps be pure there is no change in colour, but if this mixture be coloured green or red it is sophisticated with mineral spirit.

Alcohol is detected by adding to a portion of the turps a little water, the whole placed in a graduated jar, allowing the height of the liquid mass to be taken before agitation. It is left to stand for a moment, after which the height of the mixture is again taken; if there be no increase in volume, the turps is pure; but if the height of the mixture has increased, the turps is sophisticated by alcohol.[1]

To recognise the possible presence of water the turps need only be mixed with benzine, and the whole agitated. In the case of the pure turps there is no cloudiness, but if it be clouded there is water in the turps.

[1] TRANSLATOR'S NOTE.—The turps and the water separate into two layers after agitation, each of which should be of the same bulk as previous to agitation; if alcohol be present the turps layer will have decreased in bulk and the aqueous layer increased in bulk to an extent equal to the diminution in volume of the turps. The alcohol which previously swelled the bulk of the turps will now swell the bulk of the water.

Testing Preservation and Improvement of Varnishes by Ageing

The properties of a varnish can only be judged by practical tests of long duration; as regards immediate information, it is hardly possible to do anything except to test its transparency, drying capacity, and lustre, which is always something.

For this purpose, a very little of the varnish to be tested is run on to a glass slab, where it is left to spread of itself to the greatest possible thinness; it is put to one side, and allowed to dry. One can then judge its translucency and finally its hardness, and its time of drying; but once more, it can only be a comparative judgment. Time alone can bring about a definite decision. To improve varnish, it must be left to stand at rest for a long time. [The varnish must be aged.] Especially oil varnish. The length of the time taken up in ageing may be as long as desired. The varnish should be left at rest in tins without emptying them and well corked. Old-fashioned painters always applied the same treatment to varnish as they did to wine, which assumed a bouquet with years. In the same way, varnishes always improve in quality; they gain in everything—in elasticity, drying capacity, clarification, hardness, and transparency. The best arrangement is to stow the tins on a bench which does not touch the ground; avoid removing them, unless necessary, and moreover never leave them half empty. It is always best to filter them through waste before using them, and once in hand not to let them be adulterated in any way.

ANALYSIS OF YELLOW AND WHITE WAX

The frequent use of wax in paintwork, as well as its other industrial or domestic applications, necessitates it being studied here to some extent in the same way as colours, oils, essential oils, and varnishes.

Wax is the essential element of all furniture and floor polishes, the difference between which only arise from the variation in its proportions with turps, its general vehicle; it is also the principal agent in the composition of certain waterproofs or preservative *enduits*, made fashionable by Thenard and D'Arcet. Wax is met with in commerce under two aspects—as natural yellow wax and in the artificial condition of white wax, which is only yellow wax decolorised by successive and repeated treatments in hot water, treatments which are rendered more energetic in the end by the addition of a little cream of tartar. Like all raw materials, bees-wax also is falsified in a general and outrageous manner; sulphur, yellow ochre, turmeric rosin, and water even are incorporated with the yellow wax. In white wax, chalk, stearine, paraffin, starch, and also tallow. The methods of analysis must therefore prove very useful to painters.

Yellow Wax.—The presence of any foreign body may first of all be detected by a special washing in distilled water, in which is melted a good-sized piece previously weighed very exactly; it is stirred constantly until completely melted. It is then let cool, after which and when it is again solid it is weighed once more; the two weights should agree, otherwise the wax is impure. If there be a loss in weight that loss gives the actual weight of the

foreign bodies, the nature of which has to be determined thus: A small portion of the suspected wax is treated by nitric acid or by spirits of salt, and heated. If a smell of sulphur is given off, the wax contains flowers of sulphur; if no sulphurous smell be given off, the operation is repeated with the same acid but diluted with water, yellow prussiate added, and if the solution be coloured blue, ochre is present.[1]

To detect adulteration with turmeric, dissolve the wax in dilute alcohol; the solution becomes yellow, and on adding a drop of ammonia it turns brown. Rosin is detected by strongly heating a portion of the wax, which, if rosin be present, gives off a smell of turpentine.

The other inert products used to adulterate wax are detected by dissolving the wax in turps; if the solution be complete without residue or deposit, the wax is pure, otherwise any residue shows there is addition of some kinds of starch.[2]

Virgin Wax—Analysis.—First of all, the operator

[1] TRANSLATOR'S NOTE.—But the presence of sulphur does not quite preclude the presence of ochre also. A wax containing sulphur would when burnt give off sulphurous acid, etc., and ochre and other mineral ingredients are best detected in the residue after dissolving the wax in turps or other solvent, *vide infra*.

[2] Not necessarily so unless it responds to tincture of iodine; sulphur does not dissolve so readily in turps, and ochres or mineral matter not at all; whilst stearine and paraffin are readily soluble therein, especially when warm. A good indication of the purity of wax is to dilute alcohol with water until the wax floats in it and no more. Take the gravity at 60° F. with a 0·950–1·000 hydrometer, and test a sample known to be pure in the same way. If pure the two samples should float in diluted alcohol of the same density. Both should float in a liquor of 0·965 and sink in one of 0·960. To get at the mineral matter, burn the wax and examine the ash.

satisfies himself as to the state of purity or possible sophistication by the same operation as indicated for yellow wax, by washing with hot distilled water, taking care to weigh the piece of wax taken before starting. After cooling, the resolidified wax is again weighed; if there be any difference in the weights, that shows that the wax contains foreign bodies, of which it is deprived by heating. To determine the nature of these bodies a fragment of the wax is treated by hydrochloric acid as already mentioned. Complete solution will occur or no solution whatever. In the first instance, if there be complete solution accompanied by pronounced effervescence, the wax contains a carbonate of lime, probably chalk.[1] If the effervescence be slight but continuous, the wax is adulterated with bone ash.[2] If solution be complete without effervescence sulphate of lime has been added.[3]

In the second case, when there is no solution, the foreign bodies in the wax not being attacked by the acid, that shows the very probable presence of barium sulphate, which may be detected more exactly by the wax with oil and a little carbon black or filtration black, and then adding a little muriatic acid; the latter will produce an evolution of sulphuretted hydrogen, the characteristic and nauseous odour of which is readily detected.[4]

[1] There is nothing to prevent the presence of carbonate of magnesia, light or heavy.

[2] It might be ground apatite or other mineral phosphate, etc.; carbonate of magnesia does not effervesce so readily in the cold as carbonate of lime.

[3] Not necessarily, unless the solution gives a precipitate with barium chloride.

[4] China clay is a more likely adulterant, but it of course would not respond to the sulphur test.

To detect stearine, fuse the wax as just said in oil in excess, and place the solution so obtained in an equal weight of water, containing basic acetate of lead; if there be stearine in the wax a greasy consistent residue is produced.[1] Paraffin is detected by treating the piece of wax by sulphuric acid, which carbonises all the wax but leaves the paraffin intact.

Selected Furniture Polish Recipes

River or rain water	4 gallons
Yellow wax	20 lb.
White soap Marseilles . . .	10 lb.
Salts of tartar, carbonate of potash .	2 lb.

Break up the wax into small pieces, scrape or rasp the soap, and run all the materials into a pot. This pot should have a much greater capacity than that represented by the bulk of these ingredients, owing to the swelling or the rising up [priming] which occurs during heating. The whole is placed on a gentle fire; if the operation be not dangerous, it at least requires watching. It is necessary to stir constantly with a wooden spatula; as soon as it begins to boil it is taken off the fire, and the results of the operation examined as follows: The spatula is taken out, and a few drops of the furniture polish let fall on to cold water, which should become milky, otherwise the solution [emulsion] is not perfect, and in that case it must be again boiled once or twice.

[1] Rosin would in a way respond to this test, but the bulky precipitate of lead rosinate would not be quite so greasy as the stearate.

But the furniture polish so made forms too saturated a solution. It must be diluted with eight to ten times its bulk of lukewarm water immediately the operation is finished.

Normal Polish for Floors, Parquets, and Woodwork

Mix 2 to 3 lb. of wax—2½ lb. generally suffice—in 1 gallon of spirits of turpentine ; solution is effected in the cold and alone, but takes a few hours. [Mistresses who put their servants to do this kind of work on the kitchen range, please note.] To proceed faster, the mixture may be heated in the water bath, but never on the naked fire nor even on a stove. The true method of working is to saturate the wax with turps, and thin it afterwards to the strength desired. In a yellow wax polish three times the amount of turps to wax must be used, but in a polish made from virgin wax only double is required, the latter being less fatty than the other.

Virgin Wax Polish for Flatting of Paints or Polishing of Varnishes

When it is desired to flat paint, ½ lb. of wax suffices for 1 gallon of turps; to polish the varnish the proportion of wax must be doubled or trebled. If new woodwork has to be waxed, in the natural state, it is polished twice at least—first time with 1 lb. of wax to the gallon of turps, the second time with 2 or 2½ lb. of wax to the gallon of turps.

To secure a good job, the polishing or rubbing with flannel should only be done the morning after the applica-

tion of the polish, when it is a case of reapplying the encaustics [polishes], polishing the varnish, or the flatting, the old foundation may be operated on; but if it be a case of repainting, the wax should first of all be removed by liquid ammonia or dilute carbonate of ammonia or the silicate. The thorough washing with several clear waters is absolutely necessary. Independently of its use in furniture polishes, etc., wax also enters into the composition of certain waterproofing compositions, and as painters are often contending against damp and moisture, here are for their benefit a few formulæ for the composition of these *enduits* or liquids against damp or nitrification :

Formulæ for a Waterproof Composition for Plaster and Stone and Damp Walls

(Thenard and D'Arcet)

Dissolve at a gentle heat on the water bath :

	Lb.
Linseed oil boiled with 10 per cent. of litharge	3
Yellow wax pure	2

The surfaces to be waterproofed should always be heated previously. Stone may be heated more strongly than plaster; the latter should not be heated above 100° C. It would be decomposed.

The waterproofing composition is applied at the temperature of boiling water, the parts being well dried beforehand. The whole is allowed to dry for six weeks or two months.

Special and More Economical Formula for Waterproofing Plaster

(By the same chemists)

	Lb.
Linseed oil boiled with 10 per cent. of litharge	1
Rosin powdered	2

Applied and dried in the same conditions as in the preceding formulæ.

By means of this composition mouldings, sculptures, statuettes may be waterproofed and hardened. In the case of statues, at the same time, the appearance of bronze may be imparted so as to produce a better illusion or appearance than by the rudimentary and common process of coating with layers of oil paints. The following is the method :

Linseed oil is saponified by caustic soda. A strong solution of common salt is then added, and boiling continued so as to impart great density to this solution, that is until the soap which is formed floats in grains on the surface. This soap is drained and pressed ; it is then dissolved in distilled water and the solution filtered. On the other hand, there are likewise dissolved in distilled water—green vitriol, 1 part, blue vitriol, 4 parts. The solution is filtered and boiled whilst pouring into it the soap solution, until the sulphate solution is completely decomposed. The addition of this metallic solution is continued so as to wash the flaky soap in a solution of sulphates. The metallic soap is washed in boiling water, then in cold water, filtered and pressed in a cloth. This sequel of operations, delicate enough, but easy enough to execute, yields an iron and copper soap which, mixed with litharge boiled oil [? fused

lead linoleate] and wax, yields a paint with which objects in plaster may be bronzed, hardened, and waterproofed as well as all articles in plaster to which it is desired to give the artistic seal and illusion of metal. To liquefy this metallic soap and to bring it into the form of a good liquid paint for the above articles, 100 oz. of linseed oil are boiled with 25 oz. of litharge in fine powder, filtered, and allowed to settle. The liquid paint is then made as follows:

	Oz.
Litharge boiled oil	30
Metallic soap	16
White wax	16

The whole is melted on the water bath and the application proceeded with, the object being previously heated in an oven if possible to 80° or 90° C., 176–194° F., at the most.[1]

These waterproofing formulæ are very old, but they are still the best, for if more practical and more convenient compositions have been made since then, their general defect is the want of penetration into the material to be waterproofed; coats hastily applied dry too quickly.

[1] This composition will undoubtedly give a good bronze, but a far prettier effect, the translator believes, would be got by precipitating the mixture of sulphates of copper and iron *in the cold*, dissolving that precipitate in a suitable solvent, applying that to the plaster cast in the cold, and baking that if need be in the oven. A saturated solution of rosinate of copper in naphtha added to zinc oxide stiff paint and applied in the same way as French painters apply their *enduit*, forms a superfine and unequalled coating of a magnificent malachite green hue. The zinc oxide might be replaced by stiff white lead paint, but stiff zinc paint was what the translator used, and the iron gas-pipe in a laboratory in which hydrochloric acid gas was being boiled all day long, and on which this composition was applied immediately above the beakers, was five years afterwards as sound as the day it was put on, and only required rubbing with paraffin oil to bring out the malachite tint in all its beauty.

They only impregnate the surface very slightly, and only form a mere insulator, the resistance of which is necessarily very limited compared with the waterproofing composition of Thenard and D'Arcet, and especially with its method of application, which has the advantage of causing it to penetrate very deeply into the substance in the heart of which it solidifies and grips itself together in the pores, thus forming on cooling a solid block with the substance completely closed up and rendered completely impermeable.

THE END

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